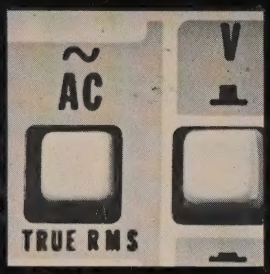
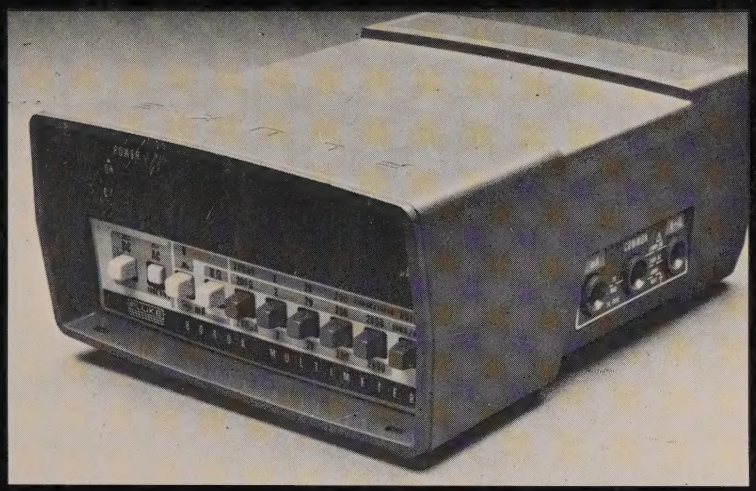
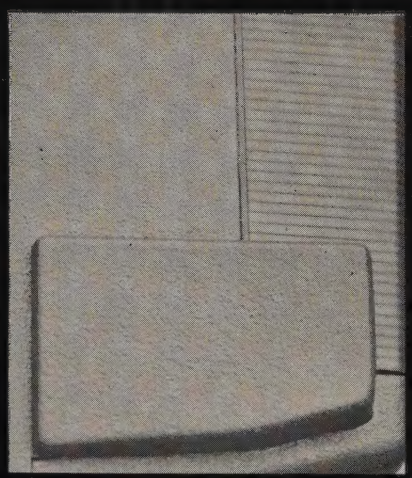
8040A
maintenance manual







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FLUKE®

8040A

maintenance manual

John Fluke Mfg. Co., Inc. • P.O. Box 43210 • Mountlake Terrace, Washington 98043

WARRANTY

The JOHN FLUKE MFG. CO., INC.* warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operations, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

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CLAIM FOR DAMAGE IN SHIPMENT

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The John Fluke Mfg. Co., Inc.* will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P.O. Box 43210, MOUNTLAKE TERRACE, WASHINGTON 98043*.

* For European customers: FLUKE (Nederland) B.V.
Ledeboerstraat 27
Tilburg, Netherlands

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Change/Errata Information

Issue No: 2 10/78

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's PCB revision letter is lower than that which is indicated at the beginning of the change/errata.

2. No revision letter is indicated at the beginning of the change/errata.

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Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 8040A Multimeter provides the accuracy and portability required in today's field service work. A slide-out sunshade protects the 4½ digit LED display from glare when operating the 8040A in adverse lighting conditions. The small size and battery power add to the portability; yet the fold-away stand allows the instrument to be positioned at a convenient angle for bench top use.

1-3. The 8040A offers 20,000 count resolution in all five functions which provides measurement resolution to 0.01 ohms on the 200 ohm range and 10 microvolts on the 200 millivolt range. AC voltage and current measurements are made using true rms conversion techniques for improved accuracy in communications and industrial control applications.

1-4. Several accessories are available for use with the 8040A to expand its' capabilities. A list of these accessories is provided in Table 1-1 while more detail about each one is provided in Section 6.

1-5. Note that two of the accessories, the 80T-150 temperature probe and A81 battery charger/eliminator, are configured at the factory for particular applications. Insure that the correct form of the model number is used when ordering either of these accessories.

Table 1-1. ACCESSORIES

ACCESSORY	DESCRIPTION	ACCESSORY	DESCRIPTION
80I-600	Clamp-on current probe; 2 to 600 amps	8040A-7005K	A rechargeable Ni-Cad battery pack (batteries come secured in the battery cover)
80F-5	High voltage probe; 5 kV		
80F-15	High voltage probe; 15 kV	8040A-7007K	A battery cover intended for use with alkaline batteries (batteries not included)
80K-40	High voltage probe; 40 kV	A8I-115	Battery charger/eliminator for 115V, 50 to 60 Hz line source
81RF	High frequency probe; 20 kHz to 100 MHz	A8I-100	Battery charger/eliminator for 100V, 50 to 60 Hz line source
82RF	High frequency probe; 100 kHz to 500 MHz	A8I-230-1	Battery charger/eliminator for 230V, 50 to 60 Hz line source (U.S. type plug)
80T-150C	Temperature probe; -50°C to +150°C		
80T-150F	-58°F to +302°F		
C88	Carrying case		
A80	Deluxe test lead kit	A8I-230	Battery charger/eliminator for 230V, 50 to 60 Hz line source (European type plug)
8040A-7004K	A battery cover kit; includes 4 "C" size alkaline batteries		

1-6. SPECIFICATIONS

DC Voltage

Ranges: (Autoranging or Manual) ..... ±200 mV, ±2V, ±20V, ±200V, ±1100V

Accuracy: (6 months, 18° to 28°C)
200 mV range: ..... ±(0.05% of reading +3 digits)
2V thru 1100V ranges: ..... ±(0.05% of reading +2 digits)

Input Impedance: ..... 10 MΩ, all ranges

Normal Mode Noise Rejection: ..... Greater than 60 dB at 50 Hz and 60 Hz

Common Mode Noise Rejection: ..... Greater than 120 dB at 50 Hz and 60 Hz (1 kΩ in either lead)

Maximum Input Voltage: ..... 200 mV and 2V ranges:
500V dc or rms ac (continuous)
1100V dc or peak ac for less than 10 sec.

20V, 200V and 1100V ranges:
1100V dc or peak ac (continuous)

AC Voltage (True rms)

Ranges: (Autoranging or Manual) ..... 200 mV, 2V, 20V, 200V, 750V

Accuracy: (6 months, 18° to 28°C, from 5% of range to full range)
45 Hz to 10 kHz ..... ±(0.5% of reading +10 digits)
10 Hz to 20 kHz ..... ±(1.0% of reading +10 digits)

Input Impedance: ..... 10 MΩ in parallel with less than 100 pF

Common Mode Noise Rejection: ..... Greater than 60 dB at 50 Hz and 60 Hz (1 kΩ in either lead)

Crest Factor: 3.0

Maximum Input Voltage: ..... 200 mV and 2V ranges:
500V rms or 700V peak ac (continuous)
750V rms, 1100V peak ac or 10^7 volt-hertz (whichever is less), for less than 10 sec.

20V, 200V and 750V ranges:
750V rms, 1100V peak ac or 10^7 volt-hertz (whichever is less)

DC mA

Ranges: ..... ±200 μA, 2 mA, 20 mA, 200 mA, 2000 mA

Accuracy: (6 months, 18° to 28°C) ..... ±(0.3% of reading +3 digits)

Voltage Burden: ..... 0.25V rms max. except 0.7V rms max. on 2000 mA range

Maximum Input: ..... 2 amps (fuse protected)

AC Current (True rms, ac + dc)

Ranges: ..... 200 μA, 2 mA, 20 mA, 200 mA, 2000 mA

Accuracy: (6 months, 18° to 28°C, from 5% of range to full range)
200 μA, 2 mA, 20 mA and 200 mA ranges:
45 Hz to 20 kHz ..... ±(1.0% of reading +10 digits)

2000 mA range:
45 Hz to 3 kHz ..... ±(1.0% of reading +10 digits)

Voltage Burden: ..... 0.25V rms max. except 0.7V max. on 2000 mA range

Crest Factor: 3.0

Maximum Input: ..... 2 amps rms (fuse protected)

Resistance

Ranges: (Autoranging or Manual) ..... 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ

Accuracy: (6 months, 18° to 28°C) ..... ±(0.2% of reading +3 digits) except 20 MΩ range
±(0.5% of reading +3 digits)

Maximum Current Through Unknown: ..... 0.5 mA on 200Ω range

Open Circuit Voltage: ..... 5 volts

Maximum Input Voltage: ⚠ ..... All ranges, 250V ac or 100V dc

General

Maximum Common Mode Voltage: ..... 500V dc or peak ac

Operating Temperature Range: ..... 0°C to +50°C

Temperature Coefficient: ..... <1/10 of applicable accuracy specification per °C (0°C to 18°C, 28°C to 50°C)

Storage Temperature Range: ..... -40°C to +70°C (without batteries), -40°C to +50°C (with Ni-Cad batteries)

Relative Humidity: ..... 0 - 80% to +35°C, 0 - 70% to +50°C

Line: ..... 100/115/230V, 48-66 Hz, 1W (instrument only)
8W (charging) max.

Battery: ..... Rechargeable Ni-Cad pack (8 hr. typical operation from full charge, typical recharge time 14 hr. of ambient temperature <30°C to achieve full charge). Non-rechargeable 4 alkaline "C" cells provide 14 hr. operation (typical).

Size: ..... 6.4 cm high x 14.5 cm long x 12.4 cm wide
(2.5″ x 5.7″ x 4.9″)

Weight: ..... 1.0 kg (2.2 pounds)

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding the correct operation of the Model 8040A Multimeter. It is recommended that the contents of this section be read and understood before attempting to operate the instrument. Should any difficulties arise during operation, please contact your nearest John Fluke Sales Representative, or the John Fluke Mfg. Co., Inc., P.O. Box 43210 Mountlake Terrace WA, 98043, Telephone (206) 774-2211. A list of sales representatives is located at the back of this manual.

2-3. SHIPPING INFORMATION

2-4. The 8040A was packed and shipped in a foam container especially designed to provide adequate protection. Upon receipt, inspect the instrument for possible shipping damage.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. Operating power for the standard 8040A instrument comes from four, non-rechargeable, alkaline "C" size batteries. The power source typically provides 14 hours of instrument operation. Optionally available power sources include rechargeable Ni-Cad batteries and a battery charger/eliminator. The instrument equipped with rechargeable batteries will typically operate for 8 hours; recharging, using the charger/eliminator, takes approximately 14 hours with the instrument turned off.

2-8. OPERATING FEATURES

2-9. The location of the 8040A controls, indicators, and connectors is shown in Figure 2-1. A description of the control, indicator, or connector is provided in Table 2-1.

2-10. OPERATING NOTES

2-11. The following paragraphs describe various conditions which should be considered before operating the 8040A.

2-12. Fuse Replacement

2-13. The 8040A is equipped with a current overload fuse to protect the instrument circuitry from inadvertent applications of current in excess of 2 amps. This fuse is located behind the mA input jack and is removed by pressing in lightly on the jack then turning it counterclockwise ¼ turn to release. When replacement is necessary, use a 2 amp AGX replacement fuse.

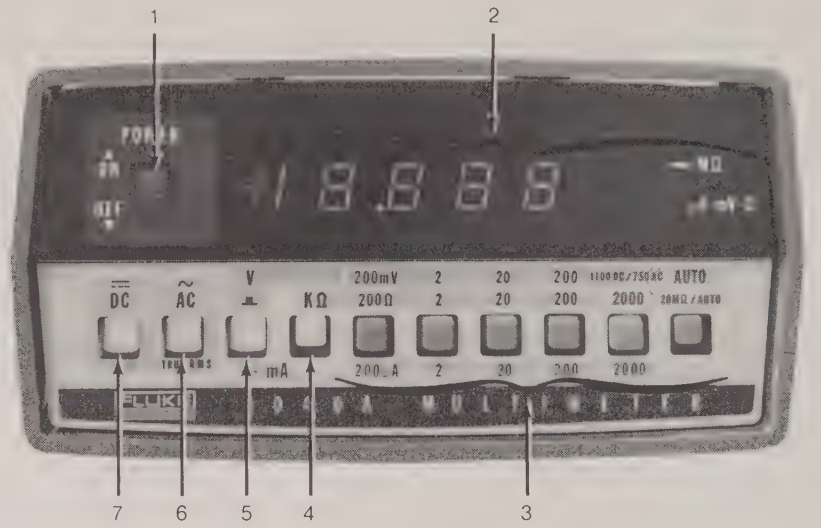
2-14. Overrange Indication

2-15. When the full scale capability of the selected range for any function is exceeded, the display will blink. The overrange indication does not necessarily mean that the instrument is being exposed to a damaging input condition.

2-16. Input Overload Protection ⚠

CAUTION

Exceeding the maximum input overload conditions can damage the 8040A. Read Tables 2-2 before attempting to operate the instrument.



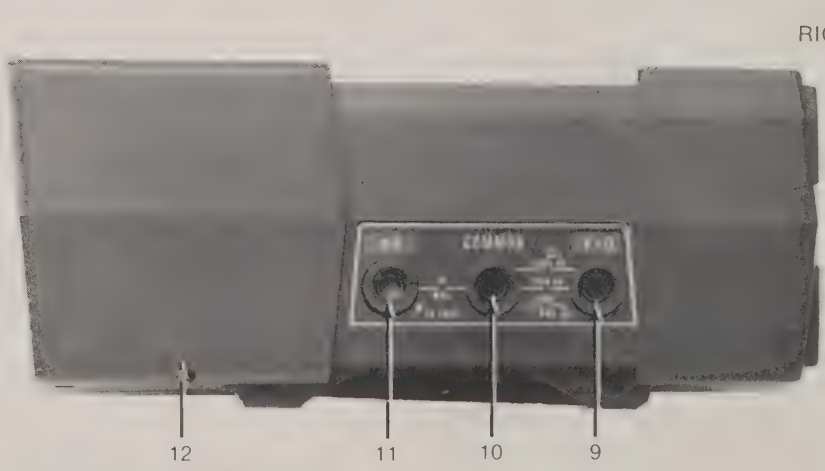


Figure 2-1. CONTROL, INDICATOR AND CONNECTOR LOCATIONS

Table 2-1. CONTROL, INDICATOR AND CONNECTOR DESCRIPTION

ITEM NUMBER	NAME	DESCRIPTION
1	POWER switch	Separates the power source (batteries or battery eliminator) from 8040A circuitry.
2	Display	A 4½ digit display (19999 maximum) of the measured input, including decimal point and polarity sign when appropriate. The units annunicators (MΩ or μA • mV • Ω) light when the applicable range is selected.
3	Range switches	Provide pushbutton selection of one of five ranges for each function, i.e., DC Voltage: 200 mV, 2, 20, 200, 1100V, or AUTO AC Voltage: 200 mV, 2, 20, 200, 750V rms, or AUTO AC or DC Current: 200 μA, 2, 20, 200, or 2000 mA Resistance: 200Ω, 2, 20, 200, 2000 kΩ, or 20 MΩ/AUTO
4	kΩ	Selects resistance measurement mode of operation.
5	V ▬ mA	Works in conjunction with the DC and AC switches to select the voltage function (out position) or current function (in position).
6	~ AC	This switch, in conjunction with item 5, selects ac voltage or alternating current measurement capability.
7	⎓ DC	This switch, in conjunction with item 5, selects dc voltage or direct current measurement capability.
8	BATTERY CHARGER/ ELIMINATOR	Jack provided for connection of the charger/eliminator accessory.
9	V-Ω	Jack for high (red) lead connection to 8040A for voltage (ac or dc) and resistance measurements.
10	COMMON	Jack for low (black) lead connection to 8040A for all functions.
11	mA	Jack for high (red) lead connection to 8040A for current (ac and dc) measurements (2A FUSE behind; push in and twist ¼ turn and pull to remove).
12	Sunshade	Shade slides forward to improve the readability of the displays in bright light environments.

2-17. The overload protection varies with the range and function selected. The maximum allowable input overload condition for each function and range is given in Table 2-2.

2-18. ASSEMBLY AND INITIAL OPERATION

2-19. It is recommended that the assembly and initial operation of the 8040A be done in accordance with the following procedure. No test equipment is required to perform this procedure; all signals observed are generated by the 8040A. This procedure may be used as an instrument operational evaluation when the 8040A is being used in locations away from normal calibration equipment.

2-20. Assemble the 8040A as follows:

a. Remove the contents of the box marked BATTERY COVER. (Four "C" size batteries, a

Table 2-2. 8040A MAXIMUM ALLOWABLE INPUT OVERLOAD CONDITIONS

SELECTED FUNCTION	SELECTED RANGE	INPUT CONNECTIONS	MAXIMUM INPUT OVERLOAD LIMITS
VDC	200 mV, 2V	V-Ω and COMMON	500V dc or V rms (continuous) 1100V dc or peak ac (for less than 10 seconds).
	20, 200, 1100V	V-Ω and COMMON	1100V dc or peak ac
DC mA	200 μA, 2, 20, 200, or 2000 mA	mA and COMMON	2 amps, 250V Fuse Protected
VAC	200 mV, 2V	V-Ω and COMMON	500V dc or ac (continuous) 750V rms, 1100V peak, or 10^7 V-Hz, whichever is less, for less than 10 seconds.
	20, 200, 750V	V-Ω and COMMON	750V rms, 1100V peak, or 10^7 V-Hz, whichever is less (continuous)
AC mA	200 μA, 2, 20, 200, or 2000 mA	mA and COMMON	2 amp, 250V Fuse Protected
kΩ	200Ω, 2, 20, 200, 2000 kΩ, or 20 M	V-Ω and COMMON	250V ac or 100V dc

battery cover, and two mounting screws for non-rechargeable batteries; an assembled pack and two mounting screws for rechargeable batteries.

CAUTION

Do not operate 8040A without battery cover in place (batteries do not have to be installed).

b. The four non-rechargeable alkaline batteries are to be mounted in the battery clips (position as indicated on 8040A case) then the battery cover secured in place with the two screws provided. When installing the battery pack note the guide tab on the edge of the cover and match it with the recess in the bottom center of the 8040A case.

2-21. The following procedure may be used to check the basic operation of the 8040A. It is not intended to be used as a verification of calibration accuracy. Proceed with the operational check as follows:

a. Turn the 8040A on.

b. Connect the red test lead to the V-Ω input terminal.

c. **(Check DC Volts Operation)** Select volts dc function (see Function Selection Examples) and the 20 range.

d. Insert the test lead probe into the BTRY TEST hole, located on the bottom of the 8040A case.

e. The 8040A display will indicate the battery voltage; between 4.0 volts and 5.8 volts.

f. **(Check AC Volts Operation)** Select the volts ac function and 200 mV range.

g. The 8040A display will indicate the ripple voltage created by the inverter. This voltage will be as much as 60 mV ac (battery operation) or 150 mV ac with the charger/eliminator as power source.

NOTE

Due to the charging of the input coupling capacitor it will take 5 to 10 seconds for this reading to settle.

h. **(Check Resistance Operation)** Select the resistance function and 2 range.

i. Insert the test probe tip into the mA input terminal.

j. The 8040A display will indicate 0.100 +2 digits.

k. **(Check DC mA Operation)** Connect the red test lead to the mA input terminal.

l. Select the dc mA function and 2 range.

m. Place the test probe tip into the BTRY TEST hole.

n. The 8040A display will indicate between 0.400 the 0.580 milliamps. (The current depends upon the battery voltage measured in step d and e.)

o. **(Check AC mA Operation)** Select the ac mA function.

p. The 8040A display will indicate the same as step n (mA input is dc coupled).

2-22. FUNCTION SELECTION EXAMPLES

2-23. Figure 2-2 provides a graphic illustration of switch positions and input connections for each 8040A function.

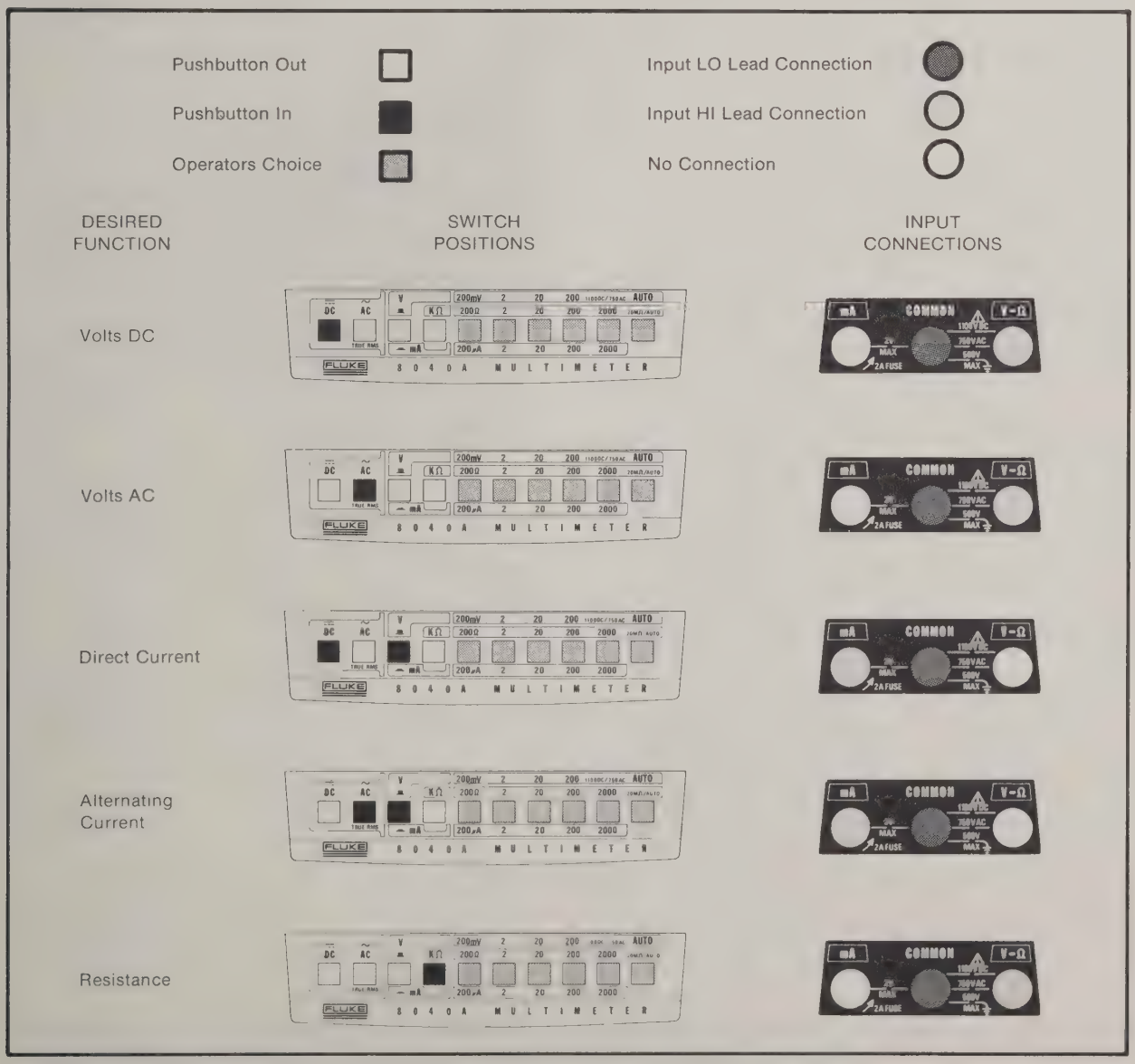


Figure 2-2. FUNCTION SELECTION EXAMPLES

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. The theory of operation for the Model 8040A is arranged under two major headings. The first, titled OVERALL FUNCTIONAL DESCRIPTION, discusses the overall operation of the instrument in terms of the functional relationships of the major circuits. The second section is titled CIRCUIT DESCRIPTION and deals with the internal operation of each major circuit in more detail. Block diagrams and simplified circuit diagrams are included, where needed, to aid in understanding the theory. The complete schematic diagrams are located in Section 7.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. Introduction

3-5. The 8040A circuitry can be divided into two major sections; an Analog section and a Digital section. The interconnection of the two major sections of circuitry, including the subsections within each section is illustrated in Figure 3-1. This section of theory will discuss the operation of the 8040A in terms of the two major sections (and subsections of each) giving a brief look at the function and interrelationship of these circuits.

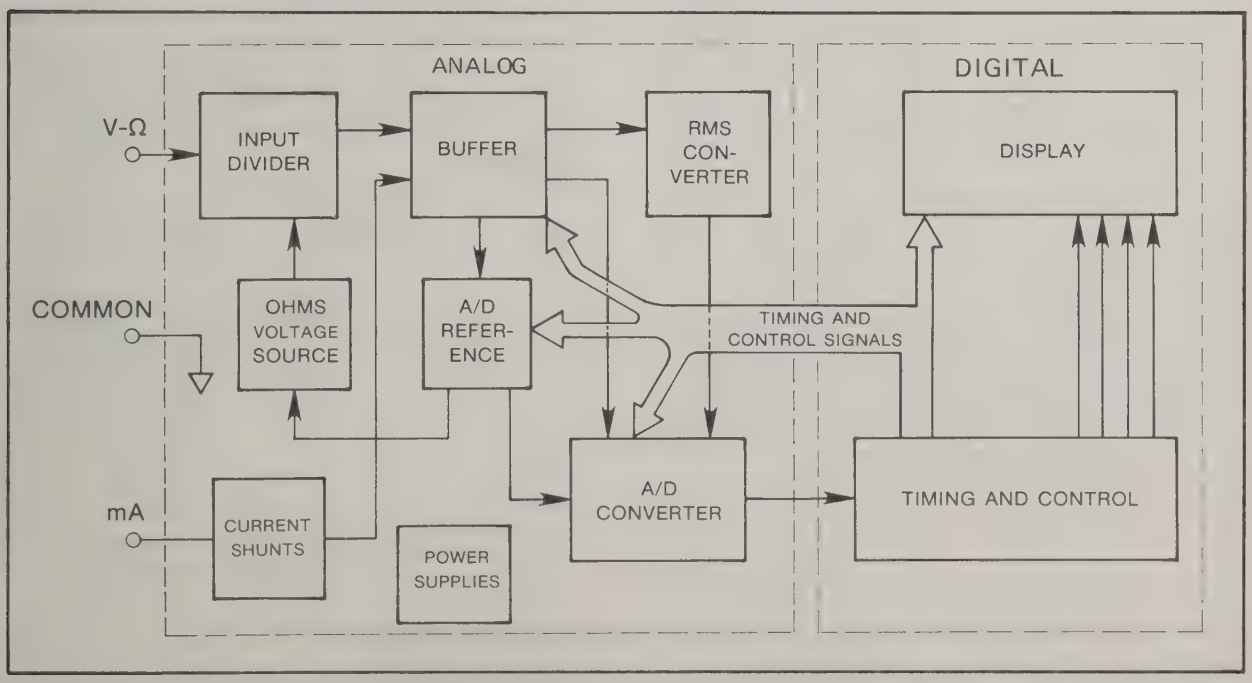


Figure 3-1. 8040A BLOCK DIAGRAM

3-6. Analog Circuits

3-7. The Analog portion of the 8040A circuitry consists of an Input Divider, Buffer, RMS Converter, Ohms Voltage Source, A/D Reference, Current Shunts, Power Supplies and A/D Converter. The inputs to be measured are connected to the Analog circuitry via the V-Ω or mA terminals. A dc voltage, directly proportional to the applied input, is developed by the Input Divider, Current Shunts, Buffer and RMS Converter and applied to the A/D Converter. This dc voltage equivalent of the applied input charges a capacitor in the A/D to a level proportional to the input. A reference voltage, opposite in polarity to the voltage representing the applied input, is then connected to the A/D causing the charged capacitor to discharge at a constant rate. The time it takes the capacitor to discharge is therefore proportional to the applied input. the Digital section of 8040A circuitry measures the time and displays it as a digital representation of the input circuit.

3-8. Digital Circuits

3-9. The Digital section consists of Timing and Control and Display circuits. The Timing and Control Signals connect the dc voltage representing the input being measured to the A/D for 100 ms then disconnect it and apply the reference voltage. At the time the reference voltage is applied the Timing and Control circuit starts counting the number of cycles of the Crystal Oscillator occur until the A/D sends a signal to the Timing and Control circuit indicating that the capacitor has been discharged to zero. The number of cycles of oscillator signal that occurred is presented on the display as the value of the unknown input being measured by the 8040A.

3-10. CIRCUIT DESCRIPTION

3-11. Introduction

3-12. This section of 8040A theory of operation will look at the subsections of circuitry, as presented in the block diagram, in more detail. When needed for explanation, simplified schematic diagrams of the circuits being discussed will be provided.

3-13. Input Divider

3-14. The Input Divider performs two basic functions when measuring unknown inputs applied to the V-Ω terminal. First, when measuring either dc or ac voltages, the divider is used to scale the input voltages down to a level that can be handled by the Buffer. The second function of the divider is to provide resistors which can be connected in series with the unknown resistance applied to the V-Ω terminal to form a voltage divider. The Ohms Source Voltage is applied to this voltage divider and the voltage drop across the unknown resistance is measured by the 8040A to calculate the value of the resistance.

3-15. Current Shunts

3-16. The Current Shunts are a set of series connected resistors. The unknown current applied to the mA terminal develops a voltage proportional to the current, across the portion of the shunt resistors selected by the range switch. The 8040A processes the voltage developed across the shunt resistor and displays the value of the input current.

3-17. Buffer

3-18. The output voltage of either the Input Divider (measurement of dc or ac volts), the V-Ω terminal (measurement of resistance) or the Current Shunts (measurement of dc or ac mA) is applied to Q8 in the Buffer (see Figure 3-2). The gain of the Buffer is changed to compensate for the changes in the output voltage of the Input Divider and Current Shunts. A combination of buffer gain (X1 or X10) and scale factor of the Input Divider or Current Shunts is selected so that the output of the Buffer will not exceed 2V dc (or rms) for any full scale input in either the dc (or ac) voltage or current function. Because of changes in the reference voltage used in the resistance function (explained in the A/D Reference theory) the output of the Buffer, for full scale inputs, changes when the range changes. Table 3-1 provides the gain and Buffer output information for each range.

Table 3-1. BUFFER GAIN CONFIGURATION, kΩ FUNCTION

RANGE	BUFFER GAIN AND DIVISION	FULL SCALE BUFFER OUTPUT
200	X10, ÷ 1	980 mV
2 kΩ	X10, ÷ 1	980 mV
20 kΩ	X1, ÷ 1	833 mV
200 kΩ	X10, ÷ 1	980 mV
2000 kΩ	X1, ÷ 1	833 mV
20 MΩ	X1, ÷ 10	333 mV

3-19. A/D Reference

3-20. After the output of the Buffer has been applied to the A/D Converter for 100 ms the timing and control

signals disconnect the Buffer output and connect the appropriate A/D Reference voltage. Figure 3-3 is a simplified schematic diagram of the A/D Reference circuit.

3-21. When the 8040A is used to measure dc volts or current the Timing and Control circuit detects the polarity of the voltage applied to the A/D Converter in order to select the reference voltage of the opposite polarity. If, for example, the input to the 8040A is positive the Control circuits would produce a DE(-R) command which would cause the -VREF gate (part of U8) to turn on and supply a -1.0 volt reference to the A/D Converter. A negative polarity input to the 8040A will cause the Control circuit to provide a DE(+R) command to turn on the +VREF gate to apply a +1.0 volt reference to the A/D Converter.

3-22. AC voltage or current applied to the 8040A is processed by the RMS Converter so that the dc voltage (proportional to the ac input voltage) applied to the A/D Converter is always positive polarity. In the AC function (volts or current) the Control circuit produces a DE(-R) command to apply the -VREF to the A/D Converter. In the AC and DC functions the reference voltage is fixed at 1.0 volt either positive or negative.

3-23. In the resistance (KΩ) function the reference voltage changes as the input to the 8040A changes. The 8040A use a ratio ohms conversion technique to determine the value of the unknown resistance applied to the input terminals. This technique works on the principle that when a voltage (Ohms Source Voltage) is applied across series connected resistors (the Input Divider resistors and the unknown) the voltage drop across each will be proportional to the value of each resistor.

3-24. The 8040A calculates the value of the unknown resistor. The formula followed to make this calculation is:

$$R_X = R_{REF} \times V_X / V_{REF}$$

Where R_X is the unknown resistance, R_{REF} is the Input Divider resistor(s) selected by the range relays, V_X is the voltage across the unknown resistance and V_{REF} is the voltage across the Input Divider resistor(s).

3-25. Since the value of the reference resistor(s) in the Input Divider is fixed for any given range and the resistance values are a factor of 10 apart, the position of the decimal point in the Display makes the adjustment

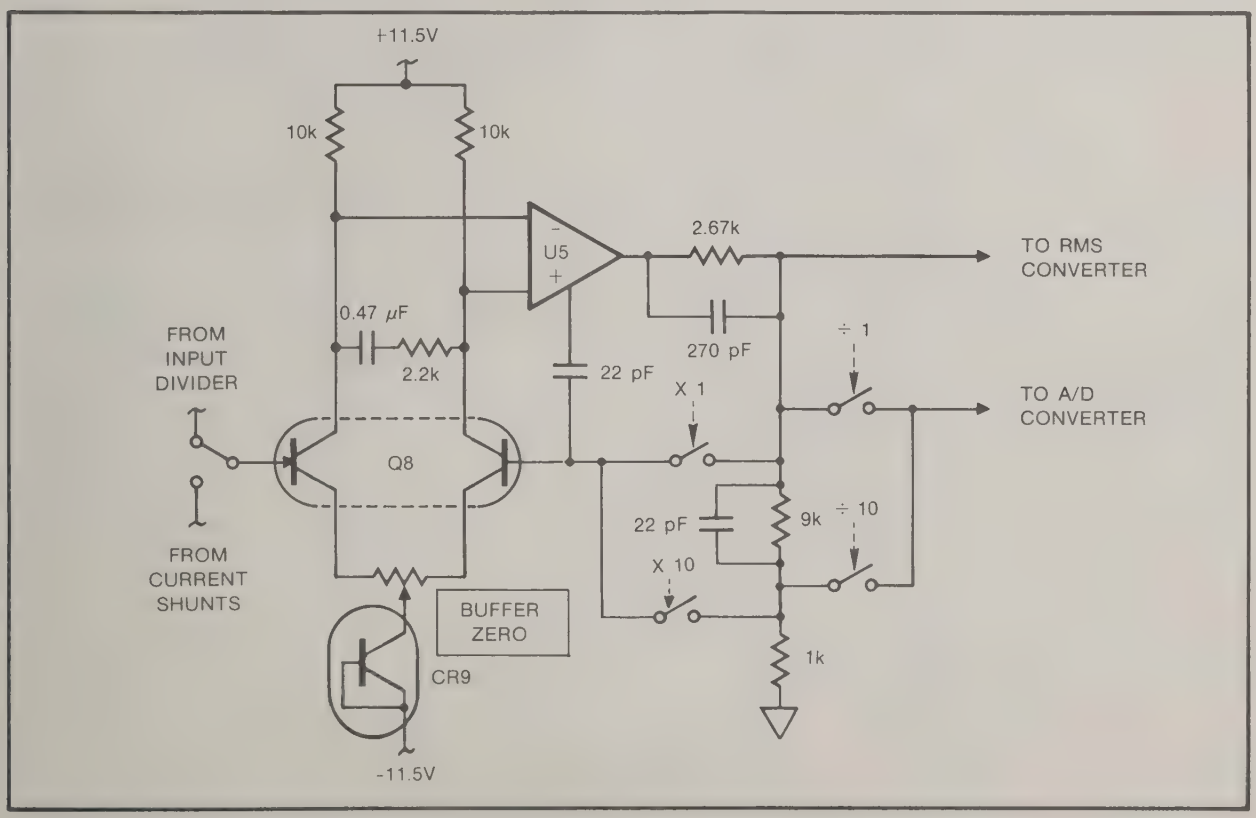


Figure 3-2. SIMPLIFIED BUFFER CIRCUIT

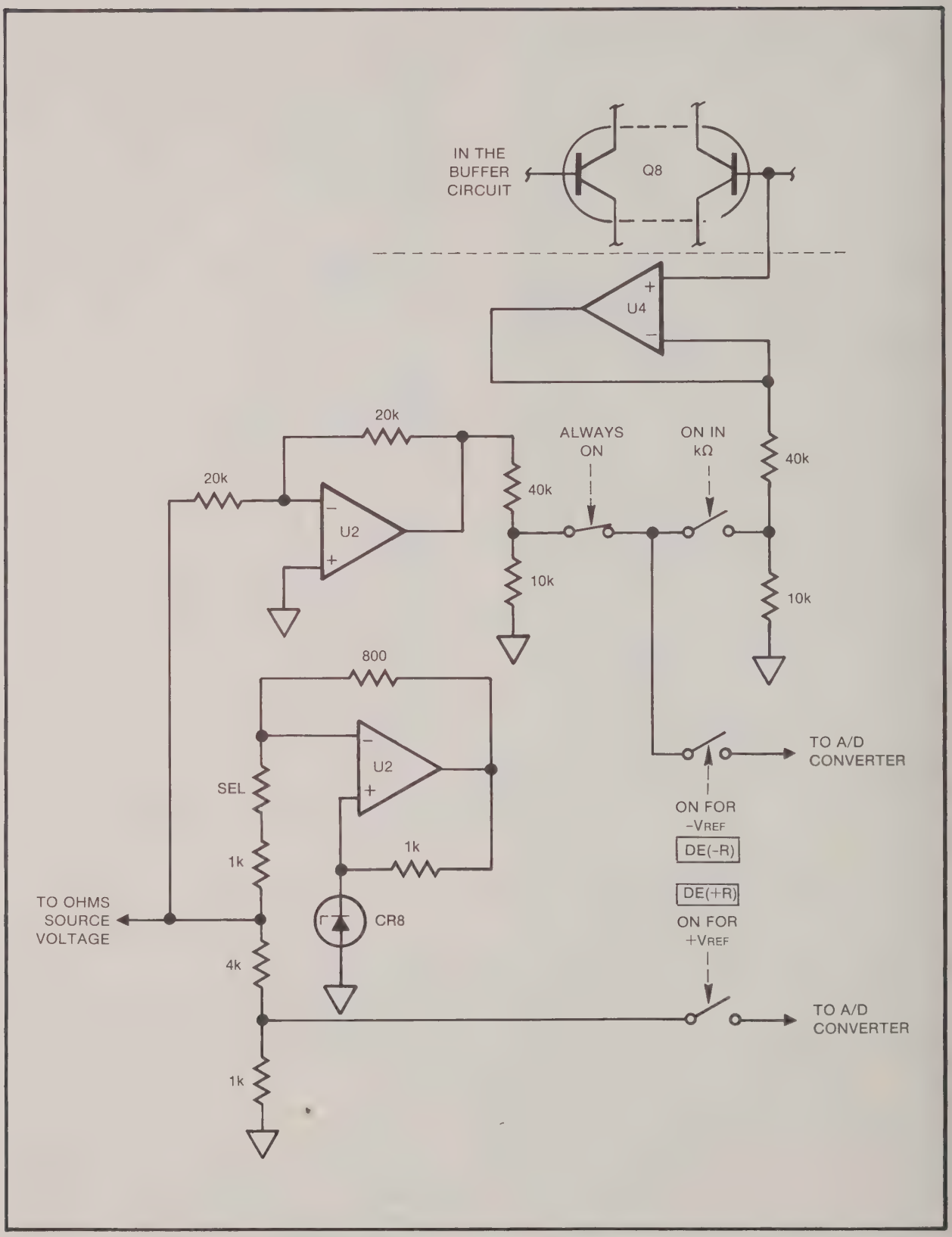


Figure 3-3. SIMPLIFIED A/D REFERENCE CIRCUIT

for the RREF term in the formula. The 8040A directly reads the value of VX and applies the resulting Buffer output to the A/D Converter for 100 ms. The value of VREF is determined by algebraically adding VX (a positive voltage) to a negative equivalent of the ohms source voltage. The resulting voltage is VREF and is applied to the A/D Converter at the end of the 100 ms application of VX.

3-26. Ohms Voltage Source

3-27. The ohms source voltage is derived from the positive voltage source in the A/D reference. Operational amplifier U1 and associated components (see schematics in Section 7) make up the unity gain buffer amplifier that supplies the ohms source voltage. The Ohms Voltage Source circuit is used exclusively in the resistance measurement function.

3-28. RMS Converter

3-29. An rms amplitude is that value of alternating current or voltage that results in the same power dissipation in a given resistance as dc current or voltage of the same numerical value. The mathematical formula for determining the rms value of an ac voltage is:

$$V_{rms} = \sqrt{\overline{V_i^2}}$$

Where Vi is the value of the ac voltage at any given instant. The 8040A RMS Converter monitors the instantaneous voltage and computes the rms value of the input signal.

3-30. The 8040A uses an implicit method for computing the rms value of the input. Figure 3-4 is a block diagram of the implicit method of calculating the rms value of an ac voltage. The output voltage of the RMS Converter (Vo) is a dc voltage proportional to the rms value of the ac voltage applied to the 8040A. This is proven by the following mathematical calculations. As indicated in Figure 3-4 $V_o = (\overline{V_i^2})/V_o$; therefore, by multiplying both sides of the equation by Vo we get $V_o^2 = \overline{V_i^2}$. By taking the square root of both sides the formula becomes $V_o = \sqrt{\overline{V_i^2}}$.

3-31. In the 8040A implicit conversion method the Multiplier-Divider function is performed using a Log-Antilog circuit. The base-emitter voltage of a transistor is almost perfectly logarithmically related to the collector current. By putting two transistors in series we obtain two times the log of the input; then by taking the antilog we obtain a voltage proportional to the square of the input (V_i^2).

3-32. The components in the 8040A RMS Converter that perform the various functions in calculating the rms value of the input are illustrated in Figure 3-5. The input signal (Vi) to the RMS Converter is first applied to a circuit which produces a current representative of the absolute value of the input. The current is then applied to the collector of the first of the two series connected transistors that, in conjunction with operational amplifier U38, produce a voltage output representing two times the log of Vi. A feedback circuit through U13 (pins 1, 2, and 3) and the upper right transistor in array U11 provide a voltage equal to the log of Vo. Subtracting the log of Vo from two times the log of Vi is equal to the mathematical function of calculating V_i^2/V_o. The final step in determining the rms value is handled by U13 (pins 7, 6, and 5), the lower right transistor of array U11 and the output filter (the 47k resistor and 0.47 μF capacitor). These components calculate the antilog of $\overline{V_i^2}/V_o$ producing an output voltage equal to $\sqrt{\overline{V_i^2}}$, this voltage being directly proportional to the rms value of the input applied to the 8040A.

3-33. A/D Converter

3-34. The A/D Converter receives the dc voltage output, from either the RMS Converter or Buffer, representing the unknown value applied to the 8040A input terminals. Timing signals from the Timing and Control circuit cause the RMS Converter or Buffer output voltage to be applied to the A/D for exactly 100 ms. The amplitude of this input voltage controls the rate at which a capacitor in the A/D is charged, so that at the end of the 100 ms integrate period the charge on the capacitor is proportional to the unknown applied to the

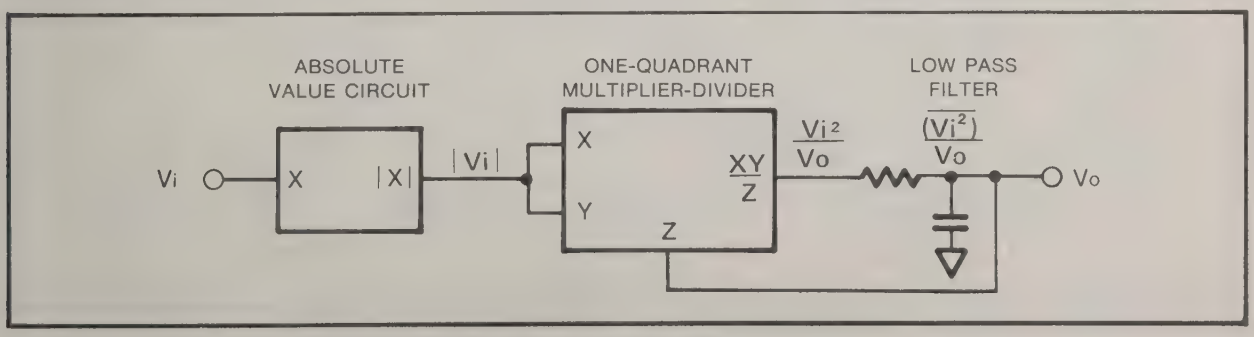


Figure 3-4. RMS CONVERTER REPRESENTATION

8040A. At the end of the 100 ms integrate period the input to the A/D is then connected to the A/D Reference. The reference voltage is selected, by the Timing and Control circuit, to be opposite in polarity from the output of the Buffer or RMS Converter. The reference voltage causes the capacitor in the A/D Converter to discharge at a constant rate. The time, called read period, that it takes the capacitor to discharge is directly proportional to the unknown input applied to the 8040A. Figure 3-6 illustrates the charge-discharge cycle of the A/D capacitor for ac or dc volts or current inputs. The charge-discharge cycle of the A/D capacitor in the KΩ function is unique because the reference voltage is inversely related to the unknown resistance value. This causes the discharge rate (slope) during the read period to change with the input.

3-35. Timing and Control

3-36. The Timing and Control circuit, in conjunction with the A/D Converter output, change what has been an analog representation of the unknown input into a digital representation. Signals from the Timing and Control circuit select the Buffer gain and the signal path for processing the unknown input. Correct timing of these signals is derived from a 1 MHz crystal controlled oscillator.

3-37. All of the digitizing process (the actual counting of the oscillator pulses during the read period) takes place in the custom integrated circuit U25. The pulses accumulate, during the read period, in decade counters within the custom chip. The number in each decade counter is converted to a four-bit binary code. Strobe signals, generaed by the custom chip, then cause the binary code for one decade counter at a time to be sent to the Display circuitry where the same strobe signal causes one of the LEDs of the display to be strobed on to display that number.

3-38. Display

3-39. The custom chip provides strobe signals (ST0 through ST7) some of which are used by the Display circuits to turn on the LEDs one at a time. The four-bit binary coded digit information applied to the Display is first changed, by U27 (see schematic in Section 7), from the binary code to seven driver signals; one for each segment in the LEDs. The seven segment drive signals are connected in parallel to each of the display digits. The strobe signals allow only one display LED to light at a time. The strobe signal causes the digit in the display corresponding to the digit with the same significant value transmitted from the Timing and Control circuit to appear in the correct position.

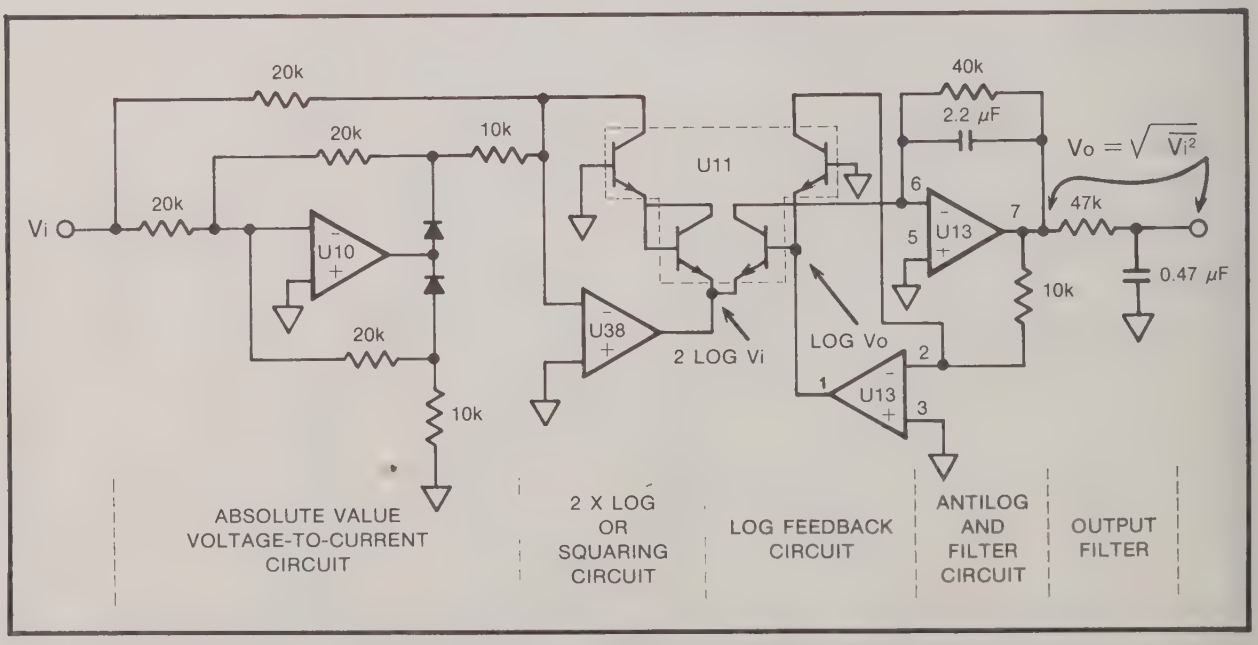


Figure 3-5. SIMPLIFIED RMS CONVERTER CIRCUIT

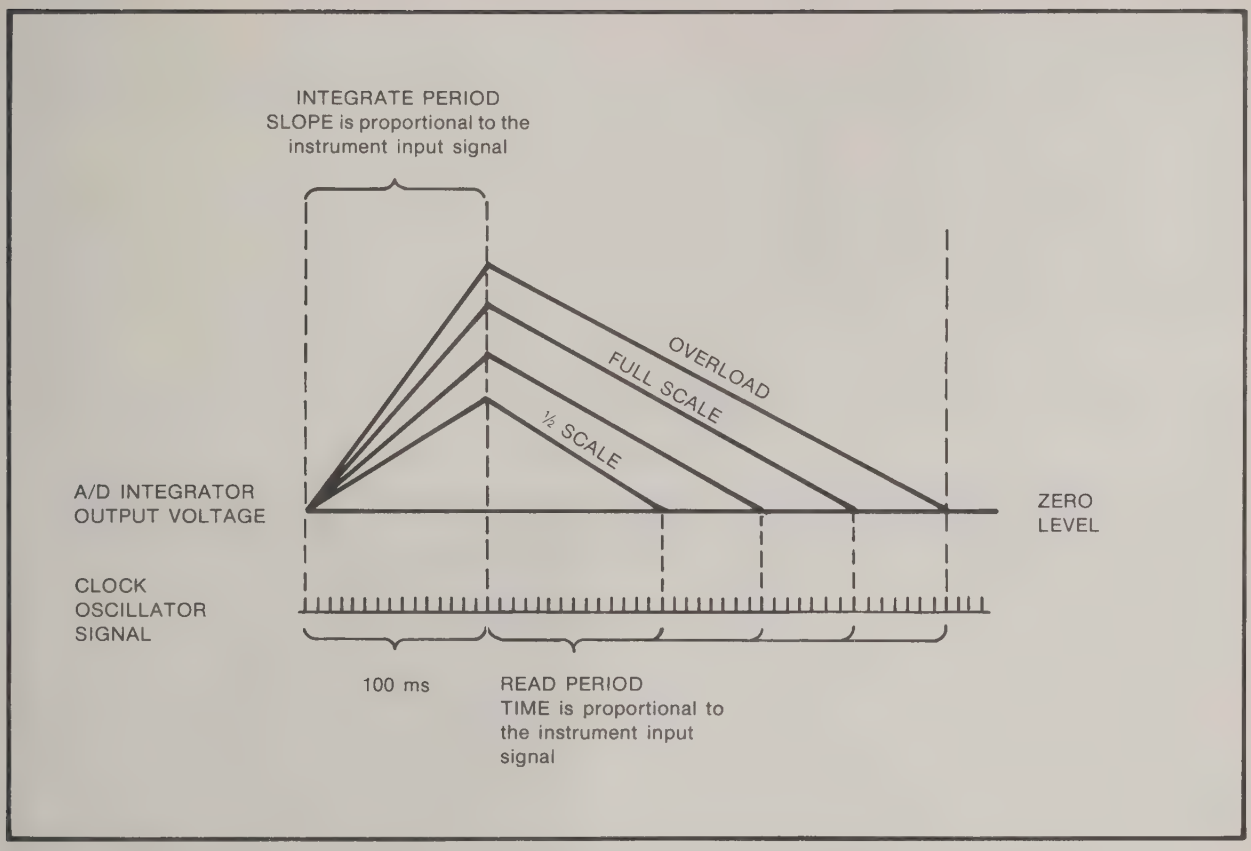


Figure 3-6. DUAL-SLOPE A/D CONVERSION TIMING FOR VAC OR VDC INPUTS

Section 4
Maintenance

WARNING!

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains information on service, general maintenance, performance tests, calibration, and troubleshooting. The performance test is recommended as a preventative maintenance tool, and should be executed when it is necessary to verify that the instrument is operating within the specification limits. A calibration interval of 6 months is recommended to insure that the 8040A performs within the specifications stated in Section 1.

4-3. Table 4-1 lists the recommended test equipment necessary to maintain the 8040A. If the specified equipment is not available, other equipment having equivalent specifications may be used.

Table 4-1. RECOMMENDED TEST EQUIPMENT

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
AC Calibrator	Voltage Range: 0 to 750V ac Frequency Range: 45 Hz to 120 kHz Voltage Accuracy: 45 Hz to 10 kHz . . . . . 0.1% 10 kHz to 120 kHz 0.2%	John Fluke Model 5200A and 5205A
DC Calibrator	Voltage Range: 0 to 1100V dc Accuracy: ±0.005%	John Fluke Model 3330B
DC Current Calibrator	Current Range: 0 to 2 mA Accuracy: 0.03%	John Fluke Model 3330B
DC Current Calibrator	Current Range: 2 mA to 2A Accuracy: 0.03%	John Fluke Model 382A
Digital Multimeter	DC Voltage Accuracy: 0.1%	John Fluke Model 8040A
Resistor Decade	Resistance Accuracy: ±0.04%	ESI DB62
Oscilloscope	General Purpose with 10 MΩ probe	Tektronix 465
Counter	±25 ppm at 1 MHz	John Fluke Model 1900A

4-4. GENERAL MAINTENANCE

4-5. Access Information

4-6. Use the following procedure to gain access to the interior of the 8040A:

1. Set the POWER switch to OFF and disconnect the battery charger eliminator, if attached.

2. Remove the fuse from the mA jack (press in, turn counterclockwise ¼ turn to release).

3. Remove the two screws holding the battery holder to the rear of the instrument and remove the holder and batteries.

NOTE

The rechargeable batteries are secured to the battery holder and are removed as one unit.

4. Remove the screw from the center of the rear panel of the instrument case and slide the 8040A out of the case.

NOTE

Do not attempt to remove the sunshade when the 8040A is in the case. The sunshade does not have to be removed to slide the instrument out of the case.

CAUTION

There are two wires connecting the 8040A circuitry to the battery contactors in the case. Use care not to place excessive strain on these wires.

5. Unplug the battery power wires from the 8040A circuit board.

6. Loosen the two screws securing the circuit board to the top of the front panel. DO NOT REMOVE THEM!

7. Remove the two screws securing the circuit board to the bottom of the front panel.

8. Set the 8040A, front panel up, on a flat surface and gently lift the bottom edge of the front panel up to clear the switch buttons. Gently lay the switch and display sections of the A1 pcb down on the flat surface.

CAUTION

Do not bend the circuit board backwards past the flat position as damage to the flex joints may occur.

9. Remove the circuit shield covering the A4 (Input) pcb and switches for inspection or troubleshooting purposes. One screw holds it in place.

10. The A4 pcb can be removed with upward pressure and a gentle rocking motion.

11. When reassembling the 8040A, protect the flexible lands by first folding the switch section of the A1 pcb then the display section up towards the vertical A2 and A3 pcbs. Tip the bottom edge of the front panel up to clear the switches. Insure that the A2 and A3 boards fit into the plastic board edge retainers on each side.

4-7. Cleaning

4-8. Clean the front panel and case with denatured alcohol or a mild solution of detergent and water. Clean dust from the circuit board with low pressure dry air. Contaminates can be washed from the circuit board with demineralized water and a soft brush (avoid getting excessive amounts of water on the switches).

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These solutions will react with the plastic materials of the instrument.

4-9. Fuse Replacement

4-10. A fuse, located behind the mA input jack, provides protection against current inputs that exceed 2 amps. When replacement is required, use only a AGX 2 amp fuse as a replacement. This fuse is removed by pressing in on the mA input terminal then turning it counterclockwise ¼ turn to release.

4-11. PERFORMANCE CHECK

4-12. The performance check provides a means of verifying that the overall operation of the 8040A is within required limits. This procedure can be used as a acceptance test for receiving inspection and as a periodic maintenance check. Refer to Table 4-1 for the test equipment recommended for these checks. Should the 8040A fail to meet the requirements of these checks calibration and/or troubleshooting will be necessary. See Table 4-1 for recommended calibration equipment. Perform this procedure under environmental conditions of 23 ±5°C at relative humidity less than 80%.

WARNING

REFER TO THE REQUIRED METHOD FOR VOLTAGE SOURCE CONNECTION (THIS SECTION) FOR VOLTAGE SOURCE CONNECTION PROCEDURE.

4-13. DC Volts

4-14. This procedure requires the output of a dc voltage source (see Table 4-1), set to specified levels, to be applied to the 8040A V-Ω and COMMON input while the display is observed to be within specific limits. Select the DC V function then refer to Table 4-2 for the ranges and inputs for the performance check.

Table 4-2. DC VOLTAGE PERFORMANCE CHECK

8040A RANGE	DC VOLTS INPUT	8040A DISPLAY LIMITS
200 mV	190.00 mV	189.87 to 190.13
2	1.900V	1.8988 to 1.9012
2	0.90V	0.8993 to 0.9007
20	19.00V	18.988 to 19.012
20	9.00V	8.993 to 9.007
200	190.00V	189.88 to 190.12
200	50.00V	49.95 to 50.05
1100 dc	1000.00V	999.3 to 1000.7
1100 dc	450.00V	449.6 to 450.4

4-15. AC Volts

4-16. During this procedure ac voltage levels at specified frequencies are applied to the 8040A V-Ω and COMMON inputs and the displays observed to be within specific limits. Select the AC V function then refer to Table 4-3 for the ranges and inputs for the performance check.

4-17. Resistance Measurements

4-18. This procedure calls for precision resistance to be applied to the 8040A V-Ω and COMMON inputs and the display observed to be within specified limits. Select the KΩ function then refer to Table 4-4 for the ranges and inputs for the performance check.

4-19. Direct Current

4-20. This procedure calls for known values of direct current to be applied to the 8040A mA and COMMON inputs and the display observed to be within specified limits. Select the DC mA function then refer to Table 4-5 for the ranges and inputs for the current check.

4-21. Alternating Current

4-22. The alternating current mode of operation need not be checked because the accuracy of the shunts is established by the direct current check and the frequency response is determined by the ac converter which is checked during the ac voltage check.

Table 4-3. AC VOLTAGE PERFORMANCE CHECK

8040A RANGE	AC VOLTS INPUT	INPUT FREQ.	8040A DISPLAY LIMITS
200 mV	190.0 mV	50 Hz	188.95 to 191.05
200 mV	190.0 mV	5 kHz	188.95 to 191.05
200 mV	190.0 mV	20 kHz	188.00 to 192.00
2	1.900V	50 Hz	1.8895 to 1.9105
2	0.900V	10 kHz	0.8945 to 0.9055
2	1.900V	20 kHz	1.8800 to 1.9200
20	19.00V	50 Hz	18.895 to 19.105
20	8.00V	5 kHz	7.950 to 8.050
20	19.00V	20 kHz	18.800 to 19.200
200	190.0V	50 Hz	0.89405 to 0.9055
200	190.0V	20 kHz	188.00 to 192.00
750	750V	50 Hz	745.2 to 7.548
750	750V	13 kHz	741.5 to 7.585

Table 4-4. RESISTANCE PERFORMANCE CHECK

8040A RANGE	RESISTANCE INPUT	8040A DISPLAY LIMITS
AUTO	SHORT ①	00.00 to 00.03
AUTO	SHORT ②	Lead Res Value
AUTO	OPEN	Flashing +1.8888
2000 kΩ	1.0 MΩ	997.7 to 1002.3
200Ω	100Ω	99.77 to 100.23 ③
AUTO	1.00 kΩ	.9977 to 1.0023 ③
AUTO	5.00 kΩ	4.987 to 5.013 ③
AUTO	10.0 kΩ	9.977 to 10.023 ③
AUTO	100 kΩ	99.77 to 100.23
AUTO	500 kΩ	498.7 to 501.3
AUTO	10.0 MΩ	9.947 to 10.058

1 Use a good quality shorting bar between the V-Ω and COMMON input terminals.

2 Connect the test leads that will be used to connect the 8040A to the decade resistance source. Place the short at the end of the test leads that will be connected to the resistance source. Note the resistance value indicated on the 8040A display.

3 Add the lead resistance value to the input resistance value to determine the correct 8040A display.

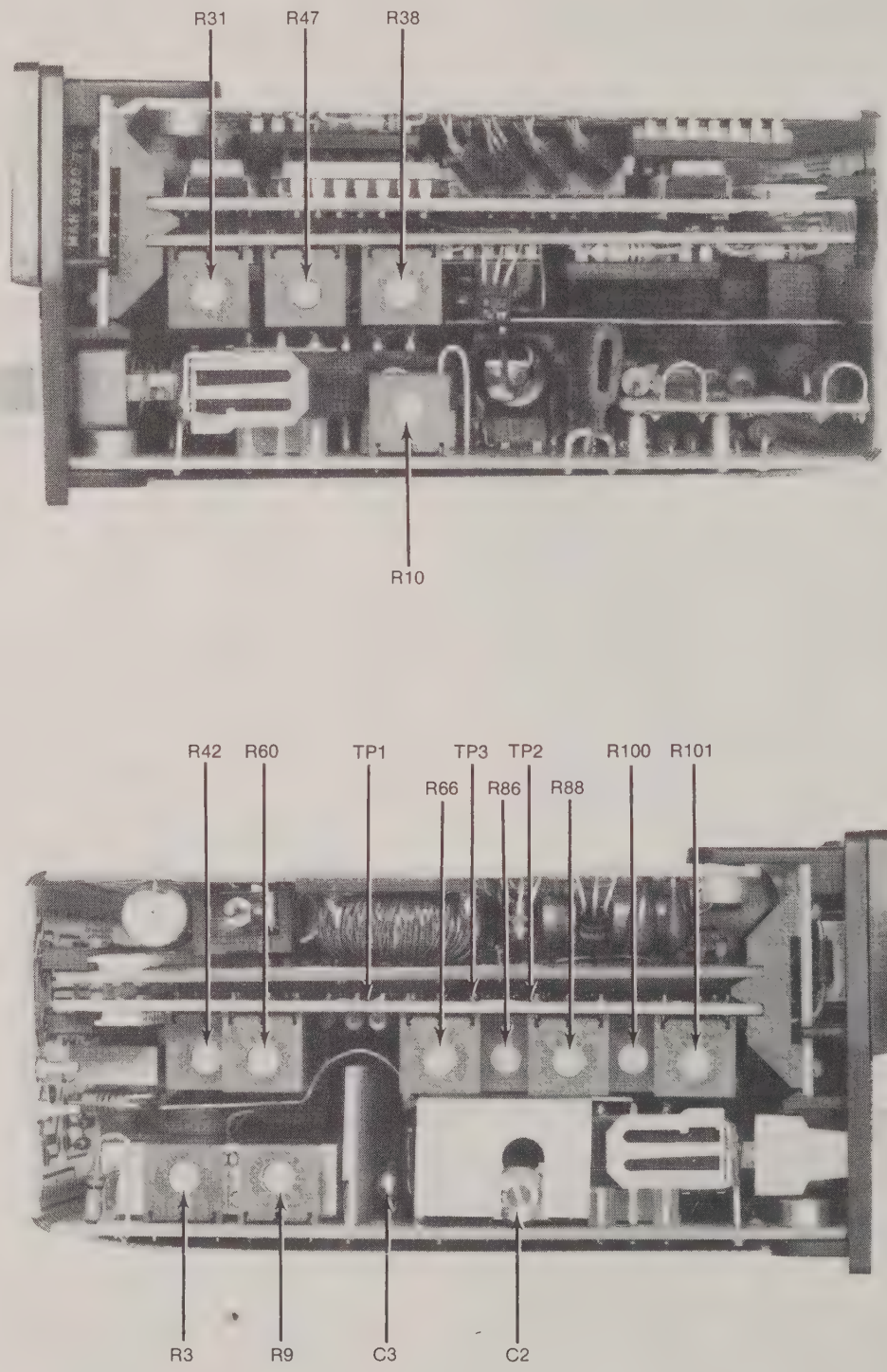


Figure 4-1. CALIBRATION ADJUSTMENT CONTROLS

Table 4-5. DIRECT CURRENT PERFORMANCE CHECK

8040A RANGE	DIRECT CURRENT INPUT	8040A DISPLAY LIMITS
200 μA	+190.0 μA	+189.40 to +190.60
2	+1.900 mA	+1.8940 to +1.9060
20	+19.00 mA	+18.940 to +19.060
200	+190.0 mA	+189.40 to +190.60
2000	+1900 mA	+1894.0 to +1906.0

NOTE

In the AC mA function inputs to the 8040A are dc coupled this allows this function to be checked with a dc mA input. Do this by selecting the AC mA function and 2 range. Apply +1.9 mA dc to the mA input. The 8040A display should read between 1.8800 and 1.9200.

4-23. CALIBRATION

4-24. Calibration of the Model 8040A should be done after repairs have been made to the electronic circuitry or when the performance check indicates the unit is not operating within the specification. Table 4-1 provides a list of test equipment required to calibrate this instrument. These procedures should be performed under environmental conditions of 23 ±5°C at a relative humidity of less than 80%.

4-25. It is recommended that the 8040A circuit board remain folded up and attached to the front panel. All adjustments and test points are accessible through the open sides of the folded up unit. The location of each calibration adjustment is illustrated in Figure 4-1. The steps of this procedure must be performed in the order presented.

NOTE

The physical position of some components may affect the ac calibration of the instrument. Avoid moving the components, especially after the calibration procedure has been completed.

4-26. Required Method for Voltage Source Connection

4-27. When a DMM is opened for servicing, the voltage source connections to it must be made in the manner shown in Figure 4-2. This method is required for PERSONAL SAFETY. Since a DMM has no earth ground connection in itself, the earth ground connection must be suplied from the voltage source. The earth ground connection will insure that voltage potential, harmful to the calibration or repair technician, will not be present on the instrument's common circuits.

WARNING

Insure that the voltage source connection method illustrated in Figure 4-2 is used. Other connection methods may cause hazardous voltages to be present on the 8040A common circuits.

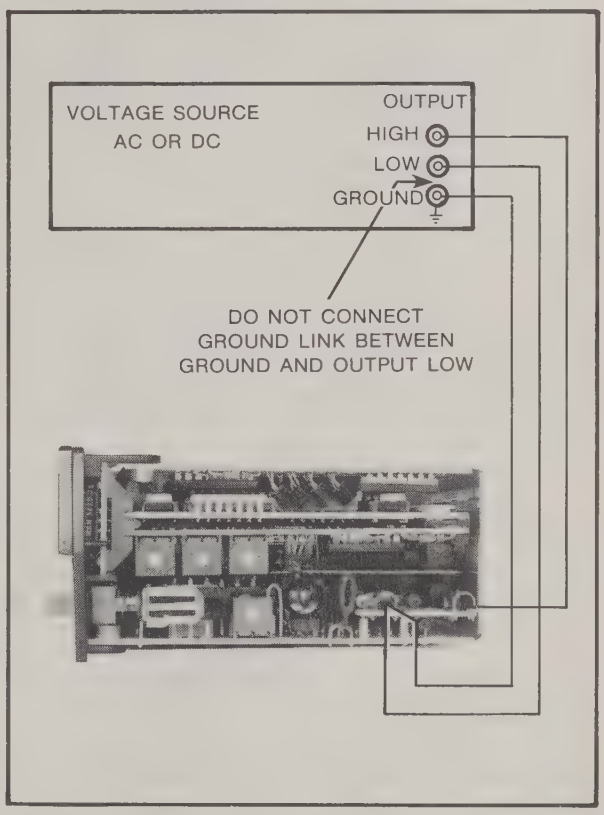


Figure 4-2. REQUIRED METHOD FOR VOLTAGE SOURCE CONNECTION

4-28. Perform the 8040A calibration as follows:

1. On the 8040A select the AC mA function and 2 range.
2. Connect the positive lead of the test equipment voltmeter to TP1 on the 8040A and the low lead to the 8040A COMMON input terminal.
3. Adjust R42 for a voltmeter reading of -0.001 to +0.001 volts.
4. Disconnect the test equipment voltmeter.
5. Select the DC V function.

Table 4-6. DC VOLTAGE CALIBRATION

STEP	RANGE	INPUT	ADJUST	8040A DISPLAY	ANNUNCIATOR	TOLERANCE
1	200 mV	SHORT	–	00.00	mV · Ω · μA	-00.02 to +00.02
2	200 mV	OPEN	–	00.00	mV · Ω · μA	-01.00 to +01.00
3	2	-1.9000V	R31	-1.9000	–	exactly -1.9000
4	2	+1.9000V	R38	+1.9000	–	exactly +1.9000
5	2	0.0000V	–	.0000	–	-.0002 to +.0002
6	2	-1.9000V	–	-1.9000	–	-1.8998 to -1.9002
7	2	-1.8000V	–	-1.8000	–	-1.7998 to -1.8002
8	200 mV	+190.00 mV	R60	+190.00	mV · Ω · μA	+189.98 to +190.02
9	200 mV	-190.00 mV	R60	-190.00	mV · Ω · μA	-189.98 to -190.02
10	Repeat steps 8 and 9 until the tolerance is equal in each polarity.					
11	AUTO	+190.00V	R9	+190.00	–	exactly +190.00
12	AUTO	+1.9000V	–	+1.9000	–	+1.8998 to +1.9002
13	AUTO	+19.000V	–	+19.000	–	+18.998 to +19.002
14	AUTO	OPEN	–	00.00	mV · Ω · μA	-01.00 to +01.00
15	AUTO	+1000.0V	R3	+1000.0	–	exactly 1000.0
16	AUTO	SHORT	–	00.00	mV · Ω · μA	-00.02 to +00.02
17	AUTO	-1000.0V*	–	-1000.0	–	-999.8 to -1000.2

* Reverse the polarity of the applied input (1000 volts) by decreasing the voltage source output to zero, inverting the output lead at the voltage source output jacks, then increase the voltage to 1000 volts (see Required Method for Voltage Source Connection).

6. Select the ranges and apply (using the recommended method) the inputs indicated in Table 4-6. Observe the 8040A for a display within the tolerances described and, when necessary, make the adjustments indicated.

7. Disconnect the dc voltage source from the 8040A input.

8. Select the KΩ function.

9. Select the ranges and apply the inputs indicated in Table 4-7. Observe the 8040A for a display within the tolerances described and, when necessary, make the adjustments indicated.

10. Disconnect the resistance source from the 8040A.

11. Select the AC mA function.

12. Select the 2 range.

13. Connect the positive lead of the test equipment voltmeter to TP2 and the low lead to the COMMON input terminal.

14. Adjust R66 for a voltmeter reading of –0.070 to +0.070 volts.

15. Apply +100 mV dc to the mA input terminal.

NOTE

The fuse holder (mA input terminal) and fuse should be connected to the positive plug on a GR type connector so that the fuse will be held in the proper place when negative terminal is plugged into the COMMON input terminal. This should be done for all inputs to the 8040A mA terminal.

16. Note the 8040A display.

17. Apply –100 mV dc to the mA input terminal.

18. Adjust R86 to obtain a display within three digits of the value of the display noted in step 16.

19. Repeat steps 13 through 18 until all parameters are met.

20. Select the AC V function and the 2 range.

21. Short the V-Ω and COMMON terminal together.

22. Turn R100 fully clockwise then adjust it counterclockwise until the 8040A display is between 0.0180 and 0.0120.

Table 4-7. OHMS CALIBRATION

STEP	RANGE	INPUT	ADJUST	8040A DISPLAY	ANNUNCIATOR	TOLERANCE
1	AUTO	SHORT ①	–	00.00	mV • Ω • μA	00.00 to 00.02
2	AUTO	SHORT ②	–	Lead Res. Value	mV • Ω • μA	–
3	2000	1 MΩ	R47	1000.0	–	exactly 1000.0
4	200Ω	100Ω	R10	100.00 ③	mV • Ω • μA	exactly 100.00 ④
5	AUTO	1 MΩ	R47	1000.0	–	exactly 1000.0
6	AUTO	100Ω	R10	100.00 ③	mV • Ω • μA	exactly 100.00 ④
7	AUTO	1.0 kΩ	–	1.0000 ③	–	.9995 to 1.0005 ④
8	AUTO	10 kΩ	–	10.000 ③	–	9.995 to 10.005 ④
9	AUTO	100 kΩ	–	100.00	–	99.95 to 100.05
10	AUTO	1.0 MΩ	–	1000.0	–	999.5 to 1000.5
11	AUTO	10 MΩ	–	10.000	MΩ	9.985 to 10.015
12	AUTO	100Ω	–	100.00 ③	mV • Ω • μA	99.98 to 100.02 ④
13	AUTO	OPEN	–	18.888 Flashing	MΩ	–

① Use a good quality shorting bar between the V-Ω and COMMON input terminals.

② Connect the test leads that will be used to connect the 8040A to the decade resistance source. Place the short at the end of the test leads that will be connected to the resistance source. Note the resistance value indicated on the 8040A display.

③ Add the lead resistance value to the input resistance value to determine the correct 8040A display.

④ Add the lead resistance value to the tolerance figures.

23. Turn R88 fully counterclockwise. Note the 8040A display; it should stop changing as the control reaches full counterclockwise rotation.

NOTE

If the display does not stop changing center R88 then return to step 13 and repeat through step 23.

24. Turn R88 clockwise slowly until the 8040A display changes by 1 or 2 digits.

25. Select the AC mA function and the 2 range.

26. Connect a voltmeter to TP2 and verify that the voltage level is between -0.070 and +0.070 volt dc.

NOTE

If the level at TP2 is not within the specified limits repeat steps 14 through 26.

27. Select the AC V function and 2 range.

28. Apply 1.0000V ac at 200 Hz to the 8040A V-Ω input terminal. Note the display.

29. Apply 0.1000V ac at 200 Hz to the V-Ω input.

30. Adjust R100 until the 8040A display indicate one-tenth of the reading observed in step 28.

31. Repeat steps 28 through 30 until no adjustment of R100 is required to obtain a one-tenth display.

32. Apply 1.0000V ac at 200 Hz to the V-Ω input.

33. Adjust R101 for an 8040A display of exactly 1.0000.

34. Apply 0.1000V ac at 200 Hz to the V-Ω input.

35. The 8040A display should be between 0.0999 and 0.1001.

36. Apply 0.0100V ac at 200 Hz to the V-Ω input.

37. The 8040A display should be between 0.0099 and 0.0104.

38. Apply 1.9000V ac at 200 Hz to the V-Ω input.

39. The 8040A display should be between 1.8980 and 1.9020.

40. Press the AUTO range switch and apply the voltages indicated in Table 4-8. Observe the 8040A for a display within the limits indicated.

Table 4-8. LOW FREQUENCY AC V CHECK

INPUT	DISPLAY
10.0 mV at 200 Hz	9.93 to 10.07
100 mV at 200 Hz	99.95 to 100.05
1.00V at 200 Hz	0.9995 to 1.0005
10.0V at 200 Hz	9.9993 to 10.007
100V at 200 Hz	99.93 to 100.07
750V at 200 Hz	749.3 to 75.07

41. Select the 750 AC range.

42. Apply 500V ac at 10k Hz to the V-Ω input.

43. Adjust C3 for an 8040A display between 499.7 and 500.3.

44. Disconnect the input from the V-Ω input.

45. Select the 200 range.

46. Apply 100V ac at 10k Hz to the V-Ω input.

47. Adjust C2 for an 8040A display between 99.96 and 100.04.

48. Repeat steps 41 through 47 until both displays are within specification limits.

49. Press the AUTO range switch and apply the voltages indicated in Table 4-9. Observe the 8040A for a display within the limits indicated.

Table 4-9. HIGH FREQUENCY AC V CHECK

INPUT	DISPLAY
100 mV at 20 kHz	99.30 to 100.70
1.00V at 20 kHz	.9930 to 1.0070
10.0V at 20 kHz	9.930 to 10.070
100V at 20 kHz	99.30 to 100.70
500V at 20 kHz	496.5 to 503.5
500V at 5 kHz	498.0 to 502.0

50. Remove all inputs from the 8040A V-Ω input.

51. Select the DC mA function.

52. Select the ranges indicated in Table 4-10 and apply the associated current input to the mA input. Observe the 8040A for a display within the limits indicated.

53. Select the AC mA function and the 2 range.

54. Apply +1.9 mA DC to the mA input.

55. The 8040A display should be between 1.8800 and 1.9200.

Table 4-10. DIRECT CURRENT ACCURACY CHECK

RANGE	INPUT	DISPLAY
200 μA	+190 μA	+189.40 to +190.60
2 mA	+1.9 mA	+1.8940 to +1.9060
20 mA	+19 mA	+18.940 to +19.060
200 mA	+190 mA	+189.40 to +190.60
2000 mA	+1900 mA	+1894.0 to +1906.0

4-29. TROUBLESHOOTING

4-30. The following information should be kept in mind while doing repair work on the 8040A. Inattention to these precautions may lead to instrument damage.

1. MOS type integrated circuits can be damaged by discharging static electricity through the device. On the A1 pcb the integrated circuits which are susceptible to damage are U22, U25 and U28; on the A2 pcb the sensitive components are U15 through U21, U23, U24 and U26; on the A3 pcb, U6, U7, U8 and U9; and A4 and A5 pcbs do not include MOS circuits.

   To avoid damaging the MOS devices you should (1) minimize handling, (2) discharge personal static before handling the device, (3) handle the MOS device by the body; avoid touching the pins on the device, (4) do not slide the MOS device over any surface, (5) avoid touching plastic, vinyl or styrofoam when working with MOS devices, and (6) always use a grounded soldering iron when installing or removing MOS devices.

2. The 8040A uses flexible connectors for physical and electrical connection of the individual sections of the A1 pcb. These flexible connectors

should never be unfolded past the flat position. Reverse flexing of these connectors can damage the solder joints.

3. The physical position of some components may affect the ac calibration of the instrument. The position of resistor network U33 and the internal shield are most likely to change the calibration if their positions were changed.

4. The low side of the charger/eliminator connector will always be at the same voltage level, with respect to earth ground, as the COMMON input terminal.

4-31. The figures, presented here in the troubleshooting section, are of signal waveforms taken at selected points in the 8040A circuitry. The amplitude of the signal and the time duration of some segments of the waveform are directly related to the input applied to the 8040A. When the input required for each figure is applied to the 8040A the manner in which the actual waveform deviates from the expected will indicate the probable cause for the malfunction.

4-32. The oscilloscope must be triggered from the signal at U26 pin 8 when observing the waveforms presented in these troubleshooting figures. Set the oscilloscope trigger level to positive and trigger slope to positive. Connect the external trigger level lead to U26 pin 8.

4-33. The signals pictured in Figure 4-3 show the two basic timing sequences of the integrate (INT) signal; waveform A for any in-range input, waveform B for any overrange input. Connect the oscilloscope input to U26 pin 8. Connect the scope ground lead to the 8040A switch frame. Exercise the 8040A in the following manner and observe the oscilloscope for the appropriate waveform.

1. Select the KΩ function and 2 range.

2. Connect a short between the V-Ω and COMMON input terminal.

3. The oscilloscope should display waveform **A.**

4. Remove the short. The instrument will indicate an overrange condition (flashing +1.8888) and the oscilloscope display will change to waveform **B**.

4-34. The probable area in the 8040A circuitry causing a malfunction that affects the INT signal may be indicated by the action of the signal under the two input conditions. The following are possible problem areas based upon the action of the INT signal.

1. If the INT signal remains constant at approximately +7 volts or –7 volts look at U26 pin 9 for the INT signal (opposite polarity to the INT signal) if the INT signal is on pin 9, U26 is defective. If the signal is not at pin 9 go on to the next waveform checks.

2. If, when an overrange input is applied to the 8040A input, the waveform at U26 pin 8 does not change from A to B proceed to the next waveform checks to further define the problem area.

4-35. The waveforms presented in Figure 4-4 represent the operation of the analog circuitry, in four key

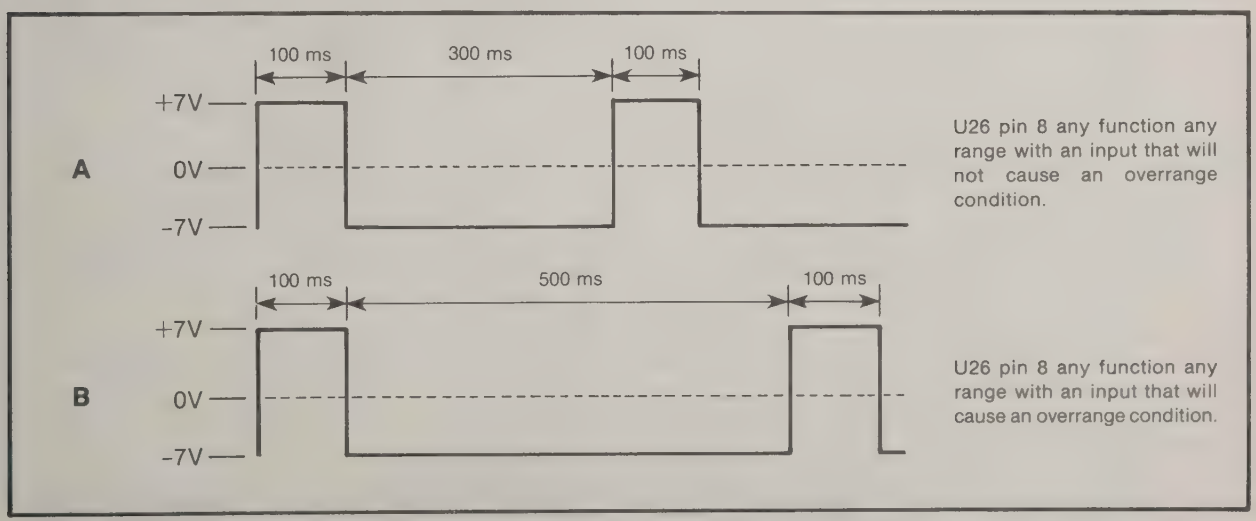
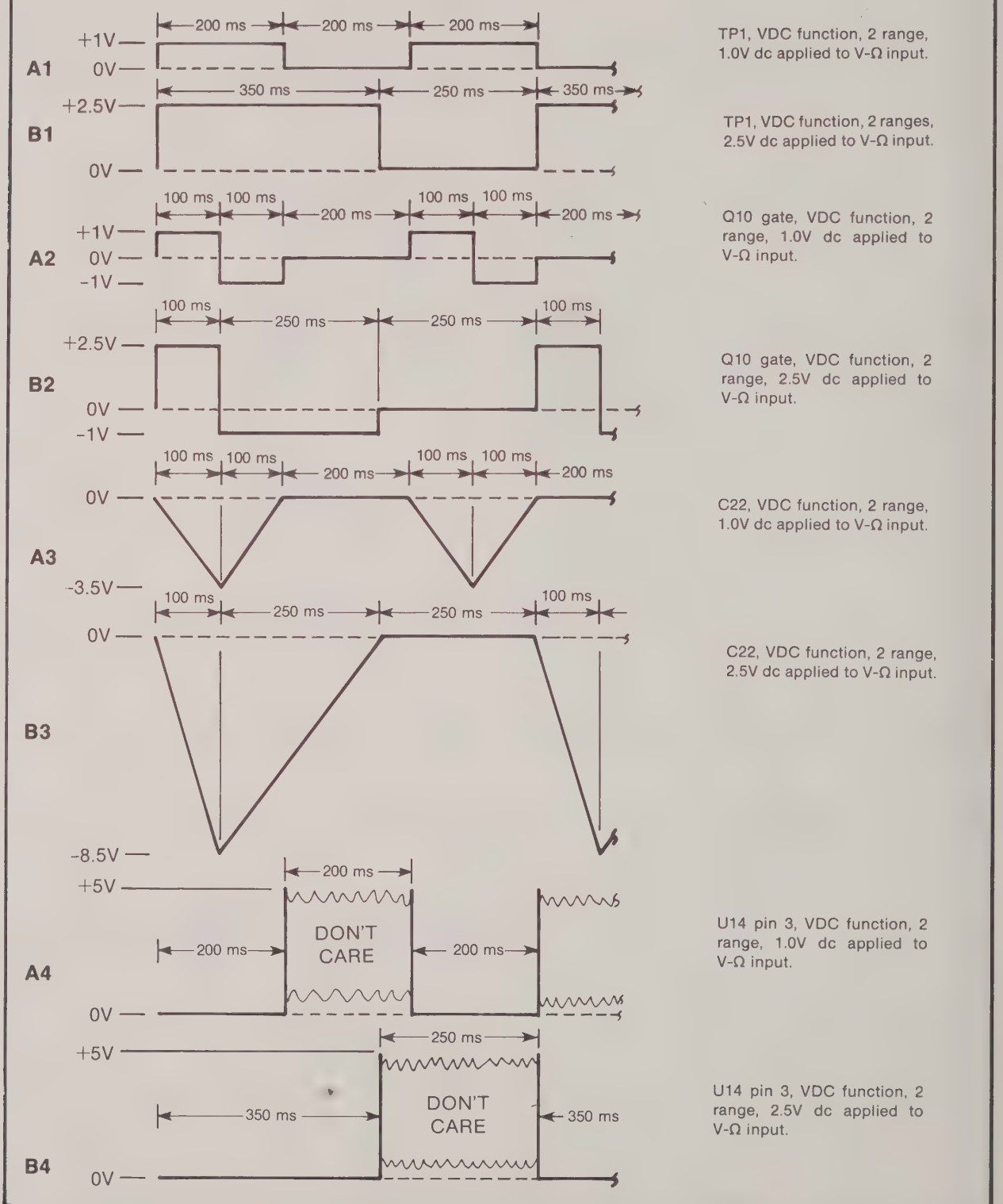


Figure 4-3. WAVEFORMS AT U26 PIN 8 FOR IN RANGE AND OVERRANGE INPUTS



TP1, VDC function, 2 range, 1.0V dc applied to V-Ω input.

TP1, VDC function, 2 ranges, 2.5V dc applied to V-Ω input.

Q10 gate, VDC function, 2 range, 1.0V dc applied to V-Ω input.

Q10 gate, VDC function, 2 range, 2.5V dc applied to V-Ω input.

C22, VDC function, 2 range, 1.0V dc applied to V-Ω input.

C22, VDC function, 2 range, 2.5V dc applied to V-Ω input.

U14 pin 3, VDC function, 2 range, 1.0V dc applied to V-Ω input.

U14 pin 3, VDC function, 2 range, 2.5V dc applied to V-Ω input.

Figure 4-4. WAVEFORMS AT TP1, Q10, C22 AND U14 FOR IN RANGE AND OVERRANGE INPUTS

locations, with an in-range and overrange input applied to the 8040A. These points are; TP1 the buffer amplifier output, Q10 gate (same as U2 pin 7) the unity gain amplifier in the A/D converter, C22 (same as U2 pin 1) the output of the integrator amplifier and U14 pin 3 the compare signal (CM) sent to the digital circuitry. (See Figure 4-5 for the oscilloscope connection points on the 8040A boards.) Check the waveforms at these points as follows.

1. Select the V DC function and 2 range.

2. Apply 1.0V dc to the V-Ω input.

3. Connect the oscilloscope input to TP1.

4. The oscilloscope display should be similar to waveform A1 in Figure 4-4.

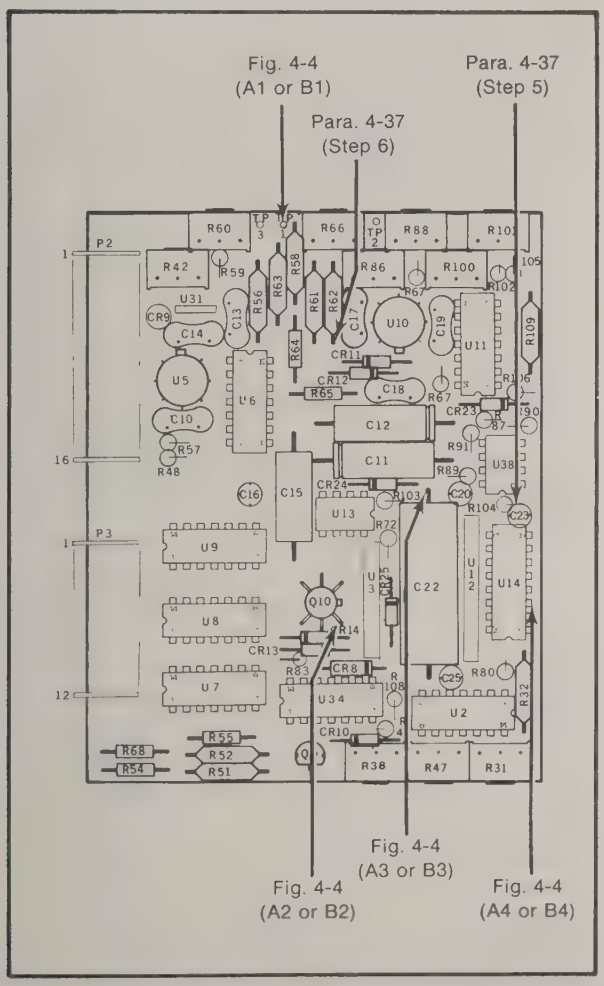


Figure 4-5. OSCILLOSCOPE CONNECTIONS FOR TROUBLESHOOTING

5. Change the voltage applied to the V-Ω input to 2.5 volts.

6. The oscilloscope display should be similar to waveform B1.

NOTE

If the amplitude of the first 100 ms of either oscilloscope display significantly deviates from waveform A1 or B1, the malfunction is probably in the Buffer circuit (Q1 through Q8, Q11, U5 and U4) or the associated circuitry. If the amplitude is correct and the duration of the second segment of the waveform is incorrect go on to the next step.

7. Connect the oscilloscope input to the gate of Q10 (on the schematic this is the same as U2 pin 7).

8. The oscilloscope display shall be similar to waveform B2.

9. Change the voltage applied to the V-Ω input to 1.0 volt.

10. The oscilloscope display should be similar to waveform A2.

NOTE

If the amplitude of the first 100 ms of either oscilloscope display significantly deviates from waveform B2 or A2 the malfunction is probably in Q10, U2, U8 or U9. If the amplitude is correct and the duration of the second segment of the waveform is incorrect go on to the next step.

11. Connect the oscilloscope input to the left end of C22.

12. The oscilloscope display should be similar to waveform A3.

13. Change the voltage applied to the V-Ω input to 2.5 volts.

14. The oscilloscope display should be similar to waveform B3.

NOTE

If the amplitude of the first 100 ms of either oscilloscope display significantly deviates from waveform A3 or B3, U2 is the probable cause of the malfunction. If the amplitude is correct and the duration of the second segment of the waveform is incorrect go on to the next step.

15. Connect the oscilloscope input to U14 pin 3.

16. The oscilloscope display should be similar to waveform B4.

17. Change the voltage applied to the V-Ω input terminal to 1.0 volt.

18. The oscilloscope display should be similar to waveform A4.

NOTE

If either oscilloscope display significantly deviates from waveform B4 or A4 the malfunction is probably in U14 or U22.

4-36. The voltage level of the first 100 ms segment of waveforms A2 and B2 should be very close to 1.0 volt and 2.5 volts respectively. If this is true yet the amplitude of the second segment of the waveform, −1.0 volts in either case,is incorrect the malfunction is probably in the A/D Reference Supply circuitry. Sections of solid state switches U7 or U8 may be leaky or inoperative or U2 may be defective.

4-37. When a malfunction affects the AC V function the probable cause of the malfunction is either the AC Converter circuitry or in the switches U7 or U9. The operation of the ac converter should be checked as follows:

1. Select the AC V function and 2 range.

2. Apply a 1.0 volt rms signal at 200 Hz to the V-Ω input.

3. Connect the oscilloscope input to TP1.

4. The oscilloscope display should show a 200 Hz signal with the positive peak being approximately +1.4 volts and the negative excursion being approximately −1.4 volts.

5. Connect a voltmeter to the junction of R104 and C23, it should indicate +1.0 volt dc.

6. If the voltage at R104 is not +1.0 volt dc, connect the oscilloscope input to the junction of R61 and R62.

7. The oscilloscope display should show a +1.4 volt halfwave rectified signal.

NOTE

If the signal at the junction of R61 and R62 is not correct U10 is the probable faulty component. If it is correct then U38, U11 or U13 may be the faulty component.

4-38. Malfunctions in the Digital circuitry may be indicated by the manner in which the 8040A display is affected. Some of the display symptoms and the probable cause for each are as follows:

1. Decimal points inoperative. Probable cause, Q13 defective.

2. Overload indication (flashing 1888) inoperative. Probable cause, U14 defective.

3. All display digits indicate zeros. Probable cause, U25 defective.

4. mV • Ω • μA or MΩ annunciator inoperative. Probable cause, U22 or DS8 defective.

5. Any individual digit not illuminated. Probable cause, the LED for that digit (DS1 through DS6) or the respective driver transistor (Q15 through Q19).

6. All digits are blank. Probable cause U25, U27, U30 or U29 defective.

Section 5
Lists of Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

a. Reference Designation or Item Number.

b. Description of each part.

c. FLUKE Stock Number.

d. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)

e. Manufacturer's Part Number or Type.

f. Total Quantity per assembly or component.

g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument revision letter by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

a. Quantity.

b. FLUKE Stock Number.

c. Description.

d. Reference Designation or Item Number.

e. Printed Circuit Board Part Number.

f. Instrument Model and Revision Letter.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	REVISION LETTER EFFECTIVITY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	8040A MULTIMETER						
A1	Main PCB Assembly (Figure 5-1)						
A2	Digital Conditioner PCB Assembly (Figure 5-2)						
A3	Analog Converter PCB Assembly (Figure 5-3)						
A4	Volt-Ohm Input PCB Assembly (Figure 5-4)						
A5	Switch Interconnect PCB	427542	89536	427542			
F1	Fuse 2 amp 250V AGX	376582	71400	AGX2	1	5	
	Fuse Clip, mA input terminal	426627	89536	426627	1		
	Battery Cover (does not include batteries or battery retainer)	418863	89536	418863	1		
	Case Assembly	426601	89536	426601	1		
	Circuit Shield	426395	89536	426395	1		
	Display Lens	426361	89536	426361	1		
	Main PCB Shield	426593	89536	426593	1		
	Manual, maintenance	427138	89536	427138	1		
	Manual, operators	427146	89536	427146	1		
	Mounting Bracket, circuit shield	426619	89536	426619	1		
	Test Leads	343657	89536	343657	1		
	PCB Retainers	426429	89536	426429	2		
	Power Button	425975	89536	425975	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	**MAIN PCB ASSEMBLY**						
C1	Cap, fxd cer, 50,000 pF -20/+80%, 500V	105676	56289	33C58	1		
C2	Cap, var, mini-cer	404301	91293	9335	1		
C3	Cap, var, 1.5 – 0.25, 2000V	435016	72982	530-006	1	1	
C4	Cap, mica, 270 pF ±5%, 500V	148452	72136	DM15F271J	1		
C5	Cap, mica, 3000 pF ±1%, 500V	436188	72136	DM19F302F	1		
C6	Cap, poly-flm, 0.047 μF ±10%, 250V	162008	73445	C280MAE/A47K	1		
C7	Cap, polycarbonate, 0.10 μF ±10%, 250V	376251	73445	C280MCH/A100K	1		
C8	Cap, mini-cer, 33 pF ±2%, 100V	354852	80031	2222-638-10339	1		
C9	Cap, poly-flm, 0.47 μF ±10%, 100V	369124	73445	C280MAH/A470K	1		
C21	Cap, elect, 100 μF -10/+50%, 10V	436170	73445	ET101X010A7	1	1	
C24	Cap, var, 1.5 – 0.25, 2000V	218206	72982	530-000	1	1	
C26	Cap, Ta, 5.6 μF ±20%, 25V	368969	56289	196D565X0025 KA1	1		
C27	Cap, Ta, 2.2 μF ±20%, 20V	161927	56289	196D222X0020 HA1	1		
C28, C29	Cap, elect, 150 μF -10/+50%, 16V	186296	73445	ET151X016A5	2	1	
CR1	Rectifier Bridge, mini	428151	04713	MDA922-1	1	1	
CR2, CR3	Diode, si, rectifier	428144	04713	1N4006	2	1	
CR4 thru CR7, CR17, CR18, CR26, CR27	Diode, si, hi-speed switching	203323	07910	1N4148	8	2	
CR15	Diode, si, rectifier	343491	04713	1N4002	1	1	
CR16	Diode, zener	110726	07910	1N964B	1	1	

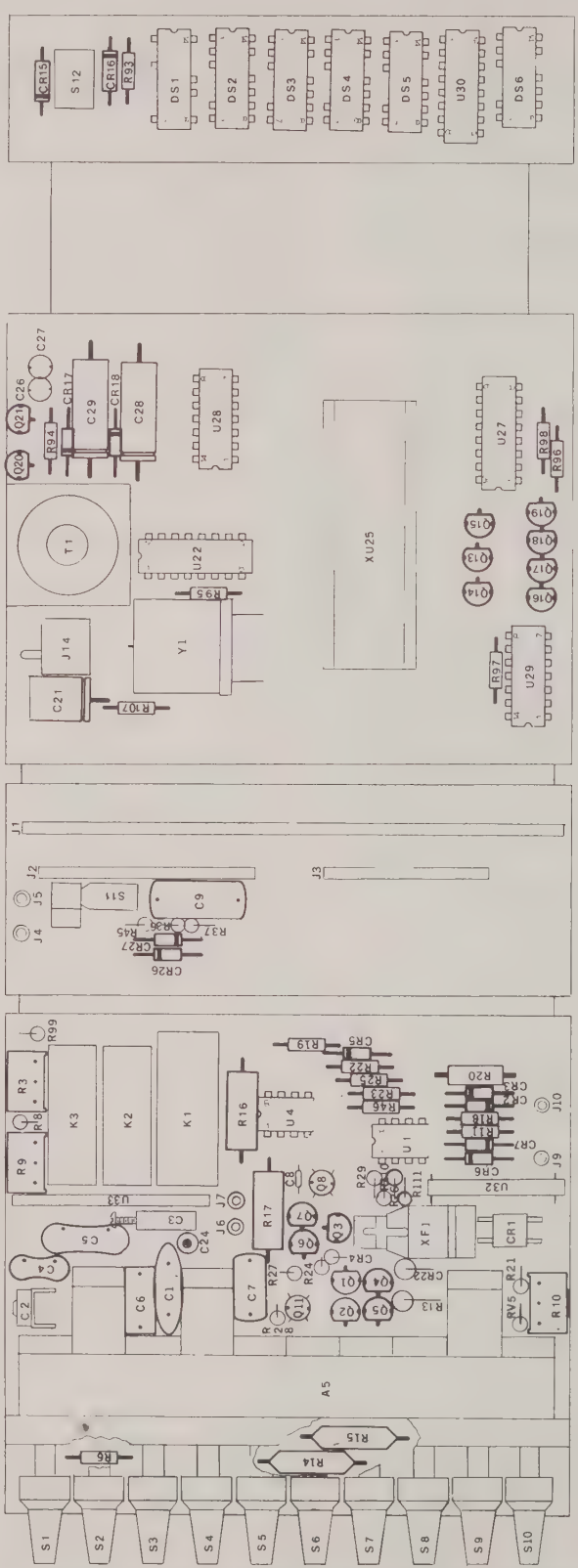


Figure 5-1. MAIN PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR22	Diode, si, rectifier	347559	05277	1N5400	1	1	
DS1	Display, LED	418400	50522	03203	1	1	
DS2 thru DS6	Display, LED	418392	50522	03202	1	1	
J14	Jack, dc power	423897	89536	423897	1		
K1	Relay	423707	89536	423707	1		
K2, K3	Relay	424408	89536	424408	2		
Q1, Q2, Q3, Q7	Xstr, J-FET, n-channel	429977	89536	429977	4	1	
Q4, Q14	Xstr, si, PNP	195974	04713	2N3906	2	1	
Q5, Q13, Q21	Xstr, si, NPN	218396	04713	2N3904	3	1	
Q6	Xstr, J-FET, n-channel	429969	89536	429969	1	1	
Q8, Q11	Xstr, J-FET, dual, n-channel	456483	89536	456483	2	1	
Q15 thru Q19	Xstr, si, PNP	340026	04713	MPS6563	5	1	
Q20	Xstr, si, PNP	418707	04713	MPS6562	1	1	
R3	Res, var, cermet, 50 ±10%, ½W	285122	71450	360S500A	1	1	
R6, R25	Res, carbon, 100k ±5%, ¼W	348920	80031	CR251-45P100 KT	2		
R9	Res, var, cermet, 500 ±10%, ½W	291120	71450	360S501A	1	1	
R10	Res, var, cermet, 100 ±10%, ½W	285130	71450	360S101A	1	1	
R11, R107	Res, comp, 9.1 ±5%, ¼W	281840	01121	CB91G5	2		
R13	Res, WW, 8.991 ±0.1%, 3W	441139	89536	441139	1	1	
R14	Res, mf, 89.91 ±0.1%, ¼W	424283	91637	MFF1-489R91D	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R15	Res, mf, 899.1 ±0.1%, ¼W	424275	91637	MFF1-4899R1D	1		
R16, R17	Res, comp, 47k ±5%, 1W	150219	01121	GB4735	2		
R18, R23	Res, comp, 2.2M ±5%, ¼W	198390	01121	CB2255	2		
R19	Res, carbon, 1M ±5%, ¼W	348987	80031	CR251-45P1MT	1		
R20	Res, comp, 8.2k ±10%, ½W	109017	01121	EB8221	1		
R21	Res, comp, 100k ±10%, ½W	108126	01121	EB1041	1		
R22	Res, carbon, 220k ±5%, ¼W	348953	80031	CR251-45P220KT	1		
R24	Res, carbon, 62k ±5%, ¼W	348904	80031	CR251-45P62 KTS	1		
R26	Res, comp, 6.2k ±5%, ¼W	221911	01121	CB6225	1		
R27, R28	Res, mf, 1k ±1%, 1/8W	168229	91637	MFF1-81001F	2		
R29	Res, comp, 1.2k ±5%, ¼W	190371	01121	CB1225	1		
R36, R45	Res, mf, 10k ±1%, 1/8W	168260	91637	MFF1-81002F	2		
R37	Res, carbon, 2.2k ±5%, ¼W	343400	80031	CR251-45P2E 2TS	1		
R46	Res, carbon, 470k ±5%, ¼W	342634	80031	CR251-45P470KT	1		
R93	Res, carbon, 22k ±5%, ¼W	348870	80031	CR251-45P22K	1		
R94	Res, carbon, 220 ±5%, ¼W	342626	80031	CR251-45P221T	1		
R95	Res, carbon, 4.7k ±5%, ¼W	348821	80031	CR251-45P4E7KT	1		
R96, R99, R110	Res, carbon, 10k ±5%, ¼W	348839	80031	CR251-45P10KT	3		
R97	Res, carbon, 1k ±5%, ¼W	343426	80031	CR251-45P1KT	1		
R98	Res, comp, 820 ±5%, ¼W	148015	01121	CB8215	1		
R111	Res, comp, 27k ±5%, ¼W	148148	01121	CB2735	1		
RV5	Res, varistor	423475	89536	423475	1	1	

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
S1 thru S10	Switch Assembly, pushbutton	418905	89536	418905	1	1	
S12	Switch, slide	423129	10389	43-100-113	1	1	
T1	Transformer, inverter	423590	89536	423590	1		
U1, U4	IC, linear, op amp	418913	12040	LM4250CN	2	1	
U22	IC, digital, C MOS hex buffer/inverter ⊗	381848	95303	CD4049A	1	1	
U25	IC, digital, P MOS (plugs into XU25) ⊗	407734	70203	C2506/407734	1	1	
U27	IC, digital, lo-pwr, Schottky, bcd-to-seven seg decoder/driver	418632	01295	SN74LS47N	1		
U28	IC, digital, C MOS, quad bilateral switch ⊗	434506	89536	434506	1	1	
U29	IC, linear, PNP, xstr array	419002	07263	CA3086N	1	1	
U30	Res Network	424531	89536	424531	1	1	
U32	Res Network	424325	89536	424325	1	1	
U33	Res Network	424309	89536	424309	1	1	
XF1	Fuse Guide, plastic	438119	89536	438119	1	1	
XF2	Fuse Contact, metal	418491	89536	418491	1	1	
XU25	Socket, IC	376244	01295	C934002	1		
Y1	Crystal, 1.000 MHz	423418	89536	423418	1	1	

⊗ Indicates MOS device which may be damaged by static discharge

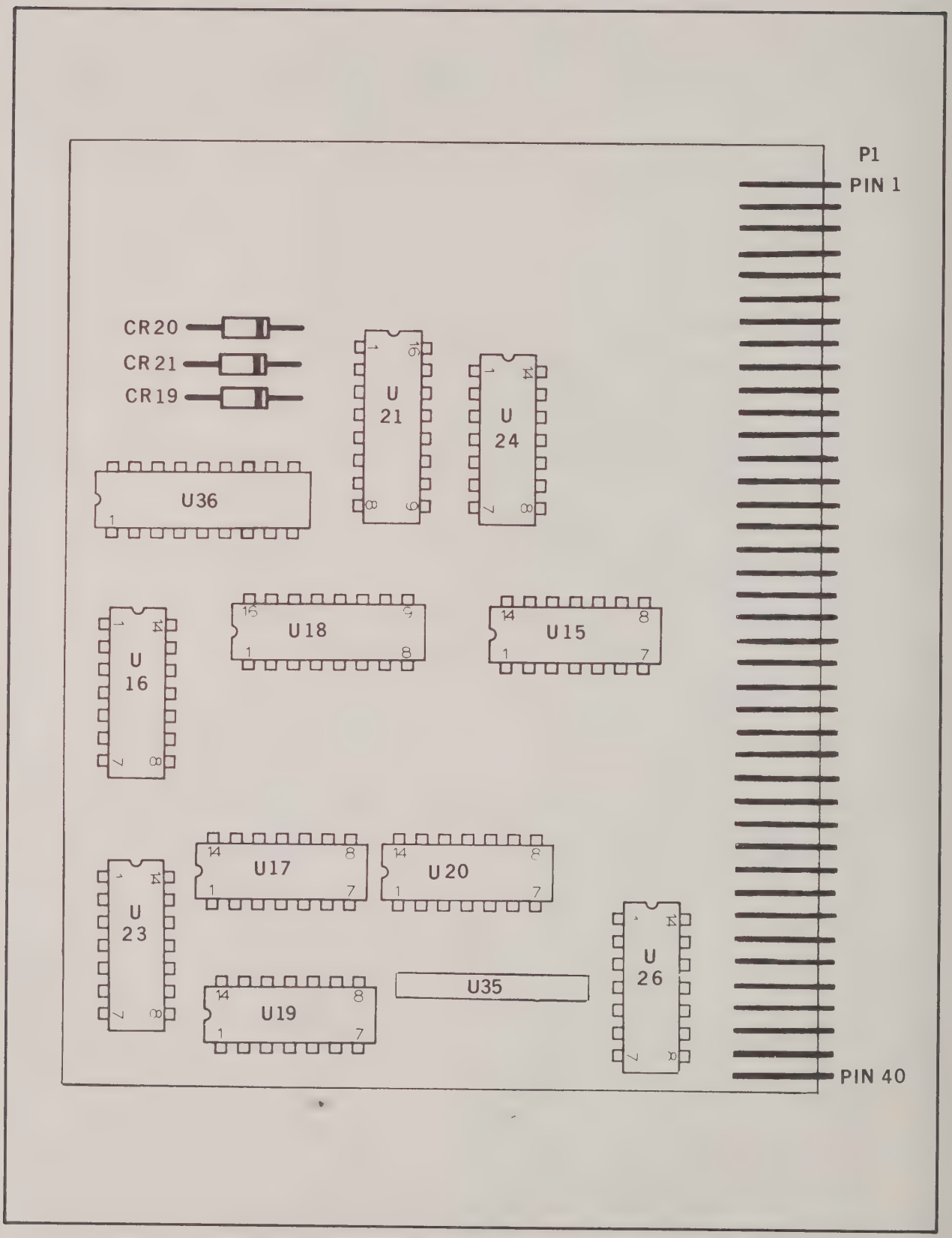


Figure 5-2. DIGITAL CONDITIONER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	**DIGITAL CONDITIONER PCB ASSEMBLY**						
CR9 thru CR21	Diode, hi-speed switching	203323	07910	1N4148	3	1	
U15, U26	IC, digital, C MOS, hex inverter ⊗	404681	95303	CD4069B	2	1	
U16	IC, digital, C MOS, quad 2-input OR gate ⊗	408393	95303	CD4071B	1	1	
U17, U23	IC, digital, C MOS, NOR gates ⊗	355172	95303	CD4001AE	2	1	
U18	IC, digital, C MOS, quad-AND-OR select gate ⊗	419010	95303	CD4019A	1	1	
U19	IC, digital, C MOS, quad 2-input AND gate ⊗	408401	95303	CD4081A	1	1	
U20	IC, digital, C MOS, hex open drain P-channel buffers ⊗	418947	12040	MM74C907N	1	1	
U21	IC, digital, C MOS, hex buffer/inverter ⊗	381848	95303	CD4049A	1	1	
U24	IC, digital, C MOS quad bilateral switch ⊗	434506	95303	CD4016AE	1	1	
U35	Res Network	412908	89536	412908	1	1	
U36	Res Network	435594	89536	435594	1	1	

⊗ Indicates MOS device which may be damaged by static discharge

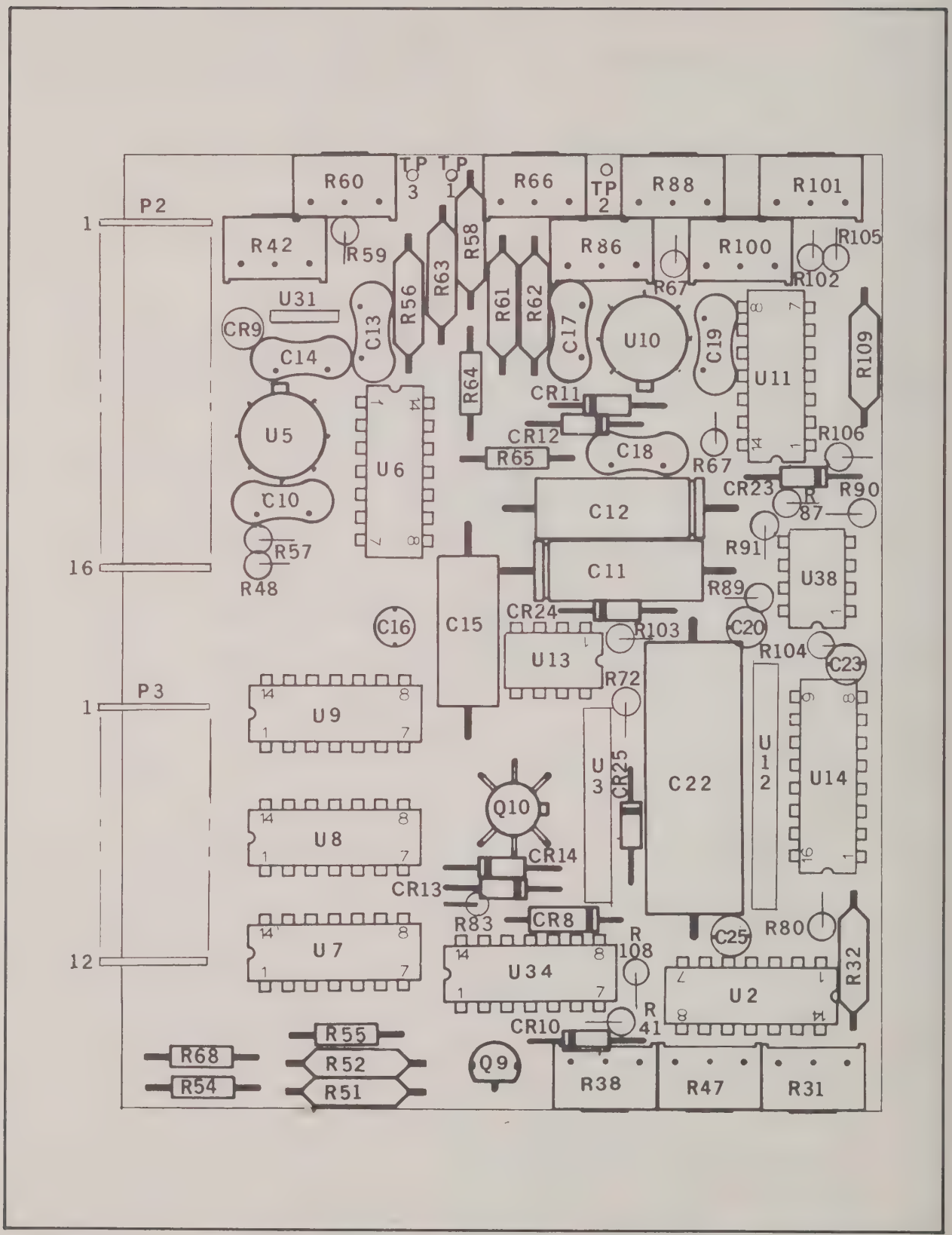


Figure 5-3. ANALOG CONVERTER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	**ANALOG CONVERTER PCB ASSEMBLY**						
C10, C14	Cap, mica, 22 pF ±5%, 500V	148551	72136	DM15C220J	2		
C11, C13	Cap, elect, 47 µF -10/+50, 25V	168823	73445	ET470X025A4	2	1	
C13	Cap, mica, 270 pF ±5%, 500V	148452	72136	DM15F271J	1		
C15	Cap, polycarbonate, 0.47 µF ±10%, 100V	288860	01281	X4630W47491W	1		
C16	Cap, Ta, 1 µF ±20%, 35V	161919	56289	196D105X0035 JA1	1		
C17	Cap, mica, 150 pF ±5%, 500V	148478	72136	DM15F151J	1		
C18, C19	Cap, mica, 5 pF ±10%, 500V	148577	72136	DM15C050K	2		
C20	Cap, Ta, 2.2 µF ±10%, 15V	364216	56289	196D225X9015 HA1	1		
C22	Cap, polypropylene, 0.47 µF ±10%, 50V	363085	89536	363085	1		
C23	Cap, Ta, 0.47 µF ±20%, 35V	161349	56289	196D474X0035 HA1	1		
C25	Cap, Ta, 0.22 µF ±20%, 35V	161331	56289	196D224X0035 HA1	1		
CR8	Diode, zener	1					
CR9	Diode, FET	393454	07910	TCR5290	1	1	
CR10, CR13, CR14, CR23, CR24, CR25	Diode, hi-speed switching	203323	07910	1N4148	6	2	
CR11, CR12	Diode, si	375907	07263	FD7222	2	1	
Q9	Xstr, si, NPN	218396	04713	2N3904	1	1	
Q10	Xstr, dual FET, n-channel	419283	89536	419283	1	1	
R31	Res, var, cermet, 50 ±10%, ½W	285122	71450	360S500A	1	1	
R32	Res, selected	1					

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R38, R42	Res, var, cermet, 100 ±10%, ½W	285130	71450	360S101A	2	1	
R41, R104	Res, carbon, 47k ±5%, ¼W	348896	80031	CR251-45P47KT	2		
R47	Res, var, cermet, 20k ±10%, ½W	291609	71450	360S203A	1	1	
R48, R57	Res, carbon, 10 ±5%, ¼W	340075	80031	CR251-45P10	2		
R51	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	1		
R52	Res, mf, 100 ±1%, 1/8W	168195	91637	MFF1-8A100F	1		
R54, R68	Res, carbon, 100k ±5%, ¼W	348920	80031	CR251-45P100KT	2		
R55	Res, carbon, 100 ±5%, ¼W	348771	80031	CR251-45P100T	1		
R56	Res, mf,2.67k ±1%, 1/8W	289587	91637	MFF1-82671F	1		
R58, R61, R63	Res, mf, 20.0k ±0.25%, 1/8W	442970	91637	MFF1-82002C	3		
R59	Res, mf, 130k ±1%, 1/8W	221648	91637	MFF1-81303F	1		
R60, R66, R88, R100	Res, var, cermet, 100k ±10%, ½W	288308	71450	360S104A	4	1	
R62	Res, mf, 9.90k ±0.25%, 1/8W	446419	91637	MFF1-89901C	1		
R64	Res, carbon, 20k ±5%, ¼W	441477	80031	CR251-45P20KT	1		
R65	Res, carbon, 10k ±5%, ¼W	348839	80031	CR251-45P10KT	1		
R67, R83, R87, R102	Res, comp, 4.7M ±5%, ¼W	220046	01121	CB4755	4		
R69, R91	Res, carbon, 3.3k ±5%, ¼W	348813	80031	CR251-45P3K3T	2		
R72	Res, carbon, 330k ±5%, ¼W	348961	80031	CR251-45P330KT	1		
R80	Res, comp, 62 ±5%, ¼W	261842	01121	CB6205	1		
R86	Res, var, cermet, 200 ±10%, ½W	285148	71450	360S201A	1	1	
R89	Res, carbon, 470k ±5%, ¼W	342634	80031	CR251-45P470KT	1		

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R90	Res, comp, 6.8k ±5%, ¼W	148098	01121	CB6825	1		
R101	Res, var, cermet, 2k ±10%, ½W	285163	71450	360S202A	1	1	
R103	Res, carbon, 15k ±5%, ¼W	348854	80031	CR251-45P15KT	1		
R105	Res, mf, 35.7k ±0.25%, 1/8W	446427	91637	MFF1-83572C	1		
R106	Res, mf, 10.0k ±0.25%, 1/8W	446435	91637	MFF1-81002C	1		
R108	Res, carbon, 13k ±5%, ¼W	441394	80031	CR251-45P13KT	1		
R109	Res, selected	2 3 4					
U2	IC, linear, op amp, quad	402669	12040	LM324N	1	1	
U3	Res Network	442814	89536	442814	1	1	
U5, U10	IC, linear, op amp	352930	89536	352930	2	1	
U6, U7	IC, digital, CMOS, quad bilaterial switch ⊗	408062	95303	CD4066AE	2	1	
U8, U9	IC, digital, CMOS, quad bilaterial switch, selected ⊗	428466	89536	428466	2	1	
U11	IC, xstr array	2					
U13	IC, linear, op amp, dual	4					
U14	IC, linear, 5-xstr array	418954	95303	CA3096E	1	1	
U31	Res Network, 2 res	424341	89536	424341	1	1	
U34	Res Network, 11 res	1					
U38	IC, linear, op amp, programmable	3					

1 CR8, R32, and U34 are a matched set order P/N 456426

2 U11 and R109 are a selected set order P/N 456434

3 U38 and R109 are a selected set order P/N 456442

4 U13 and R109 are a selected set order P/N 456459

When U11, U38, or U13 is replaced it may be necessary to reselect R109

⊗ Indicates MOS device which may be damaged by static discharge

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	**VOLT-OHM INPUT PCB ASSEMBLY**						
C30	Cap, cer, 47 pF ±10%, 2kV/3.5 kV	282145	00656	HVD347K2KV1	1		
R1	Res, comp, 100k ±10%, ½W	108126	01121	EB1041	1		
R2	Res, hi-voltage, 9.95k ±0.25%, 4W	424317	89536	424317	1		
RV1 thru RV4, RV6	Res, varistor	423475	89536	423475	5	1	

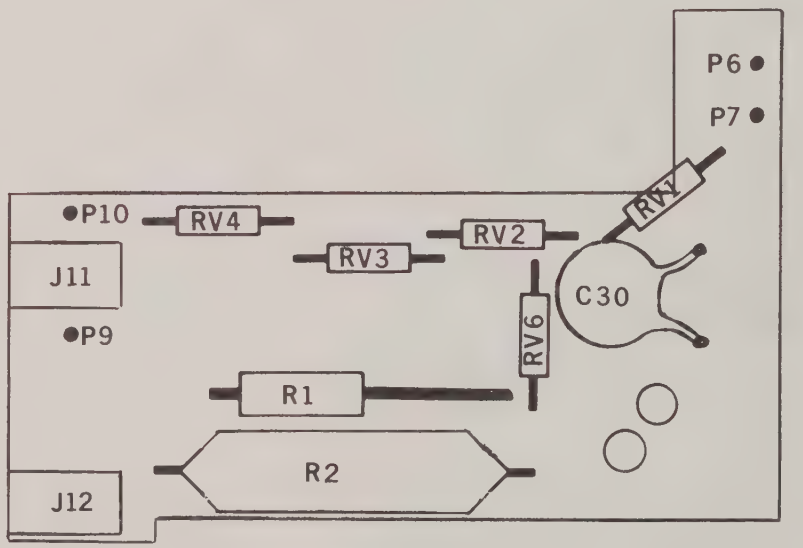


Figure 5-4. VOLT-OHM INPUT PCB ASSEMBLY

Section 6

Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information pertaining to the options and accessories available for your instrument. Each of the options and accessories are described under separate major headings containing the model or option number. The option descriptions contain applicable operating and maintenance instruction, and field installation procedures. Replaceable parts and schematics for all options are given in Sections 5 and 7, respectively.

6-3. RECHARGEABLE BATTERY PACK, 8040A-7005

6-4. Introduction

6-5. The rechargeable battery pack, item (1) in Figure 6-1, is recommended when the 8040A is to be used extensively as a portable multimeter. Four nickel cadmium (Ni-Cad) batteries allow typically 8-hours of portable operation before they require recharging. The batteries may be recharged, in about 14 hours, by connecting the Charger/Eliminator accessory to the 8040A with the instrument's power switch in OFF position.

6-6. Operation

6-7. The battery pack, as delivered, has four Ni-Cad batteries mounted to an 8040A battery cover. One of the battery retainers that secure the batteries to the cover has a peg extending from it that mates with a hole in the back of the 8040A. The peg, when the battery pack is in place on the 8040A, closes the charging path allowing the batteries to be recharged. Recharge the batteries as follows:

1. Connect the charger/eliminator to the BATTERY jack on the left side of the 8040A.

2. Turn the 8040A POWER switch to the OFF position.

3. Allow at least 14 hours of recharging a discharge battery pack. Recharge at ambient temperatures $<30°C$ to achieve full charge.

NOTE

Recharge the batteries when the battery test (V-Ω test lead inserted into the BTRY TEST jack) indicates 4.4 volts or less.

6-8. BATTERY COVER KIT, 8040A-7004

6-9. The Battery Cover Kit consists of the molded plastic battery cover and four "C" size alkaline batteries (not rechargeable). The kit is provided for those who may wish to convert an 8040A equipped with the rechargeable Ni-Cad batteries to use the less expensive alkaline batteries. These alkaline batteries will typically provide 10 hours of operation before they need replacing.

6-10. BATTERY COVER, 8040A-7007

6-11. This accessory is intended to be a replacement cover for lost or damaged battery covers. The cover does not include the battery retainers used to secure the rechargeable Ni-Cad batteries to the cover.

Figure 6-1. 8040A ACCESSORIES

6-12. CARRYING CASE (C88)

6-13. The Model C88 Carrying Case, item (2) in Figure 6-1, is a soft vinyl container designed to provide protection for the 8040A multimeter as well as increased convenience during portable operation. A detachable storage pouch provides room for test leads, spare batteries, the operators manual and small accessories.

6-14. BATTERY CHARGER/ELIMINATOR

6-15. The Battery Charger/Eliminator, item (3) in Figure 6-1, may be ordered in one of four input power configurations. Each power configuration has a unique model number which must be used when ordering this accessory. Refer to Table 6-1 for the description of each model number.

Table 6-1. BATTERY CHARGER/ELIMINATOR INPUT POWER CONFIGURATIONS

MODEL NO.	INPUT POWER
A8I-100	100V ac, 50 to 60 Hz
A8I-115	115V ac, 50 to 60 Hz
A8I-230-1	230V ac, 50 to 60 Hz (U.S. type plug)
A8I-230	230V ac, 50 to 60 Hz (European type plug)

6-16. TEMPERATURE PROBE (80T-150)

6-17. Introduction

6-18. The Model 80T-150 Temperature Probe is a self-contained temperature-to-voltage converter. It is designed to provide a direct temperature reading on the display of any high impedance voltmeter (>1 MΩ) capable of 1 mV resolution, and at least 300 full-scale readout. The probe can be configured to provide either one of two temperature displays; -50 to +150°C or -58 to +300°F.

6-19. Operating power for the probe is provided by an internal lithium battery. Typically, the battery will provide up to 1000 hours of continuous operation before replacement is necessary. An ON/OFF switch is provided to conserve the battery when the probe is not in use.

6-20. Operating Notes

6-21. PROBE LIMITATIONS

6-22. The 80T-150 probe is constructed of highly durable plastic and is suitable for measuring the temperature of inert liquids, gases and solids up to 150°C. When making the temperature measurements, observe the following precautions to prevent damage to the probe:

1. Do not expose the probe end (probe tip plus ≈2 inches of probe body) to temperatures in excess of +150°C. The remainder of the probe body should not be exposed to temperatures above +70°C.

2. Most corrosive agents will not damage the probe body. However, the aluminum probe tip will deteriorate under long term exposure to corrosive environments.

CAUTION

Long term exposure of the probe to corrosive environments will result in pitting and deterioration of the aluminum probe tip.

6-23. MEASUREMENT ERROR SOURCES

6-24. Techniques used when making the temperaure measurements can affect the accuracy of the reading. The following information will aid in making more accurate temperature measurements.

1. When the probe tip is applied to a solid surface it draws or sinks heat from the surface. Therefore, if the measured surface has a low mass (e.g., a transistor case), the indicated temperature may be lower than the actual temperature.

2. Similarly, a steady-state error or gradient exists between the measured surface and the sensing device in the probe tip. This is due to the flow of heat from the measurement surface to the probe body. The effect of the steady-state error increases as the differential between ambient and surface temperature increases.

3. To determine the actual surface temperature of a device, both the heat-sinking and steady-state errors must be considered. The correction curve given in Figure 6-2 approximates the effect of both error sources on TO-3, TO-5 and TO-18 transistor cases.

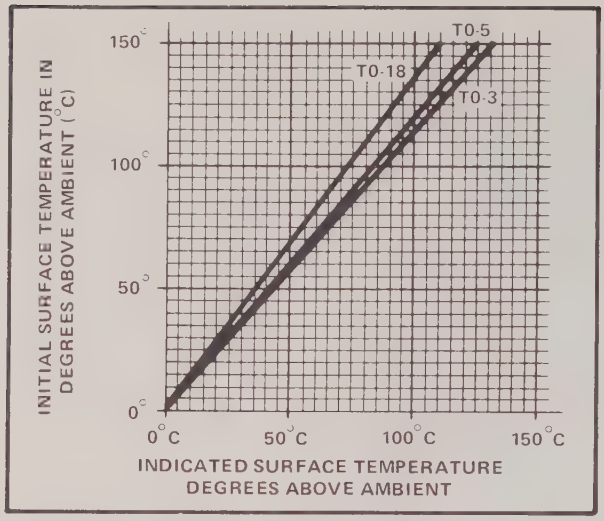


Figure 6-2. INITIAL CASE TEMPERATURE ABOVE AMBIENT versus METER READING ABOVE AMBIENT

4. RF signals applied to the 80T-150 probe tip can also cause errors in temperature measurement. Figure 6-3 defines the rf signal limits that can be tolerated without degrading measurement accuracy.

6-25. Operating Instructions

6-26. The following instructions should be adhered to in order to obtain the best results from the 80T-150 probe.

1. Connect the banana plugs on the 80T-150 to the V-Ω and COMMON input terminals. Observe polarity.

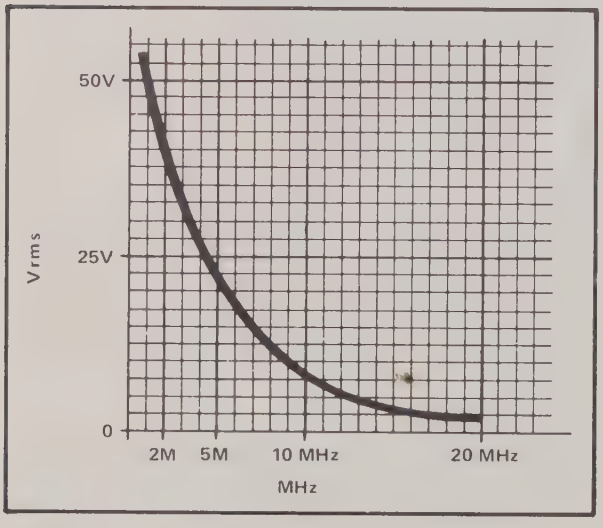


Figure 6-3. MAXIMUM RF SIGNAL LIMITS (V RMS) AT PROBE TIP

2. Select the 2 range on the 8040A.

3. Set the 80T-150 power switch to the ON position and energize the 8040A.

4. Firmly touch the probe tip to the surface to be measured, or expose it to th gas or liquid. The 8040A will display the temperature in kilodegrees. Vary the probe angle and pressure when measuring solid surface temperatures; the highest stable reading will be the most accurate.

CAUTION

The force exerted on the probe tip should not exceed 20 pounds.

6-27. DELUXE TEST LEAD KIT (A80)

6-28. The deluxe test lead kit, shown in Figure 6-4, contains two test leads with probes (red and black), and five pairs of universal probe tips. The probe tips include: alligator clips, test probe tips, pin tips, banana plug tips, and binding post lugs. A convenient plastic pouch is provided for storing the contents of the test lead kit.

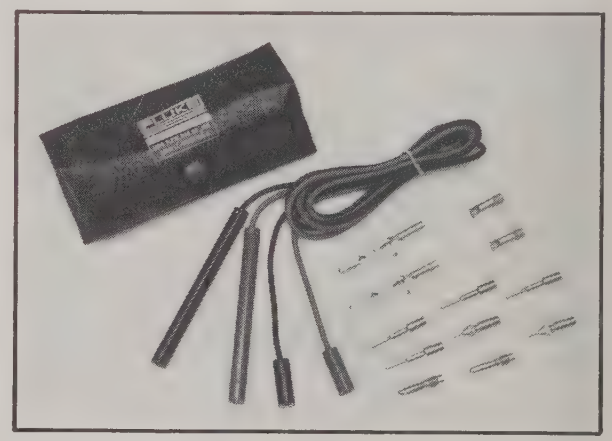


Figure 6-4. DELUXE TEST LEAD KIT

6-29. CURRENT TRANSFORMER, CLAMP-ON (80I-600)

6-30. Introduction

6-31. The Model 80I-600, as shown in Figure 6-5, is a clamp-on current transformer which is used to extend the current measurement capabilities of the 8040A. The probe is designed to measure current of 2 to 600 amperes at frequencies of up to 1 kHz with +3% accuracy. The clamp-on feature allows current to be measured without breaking the circuit under test.

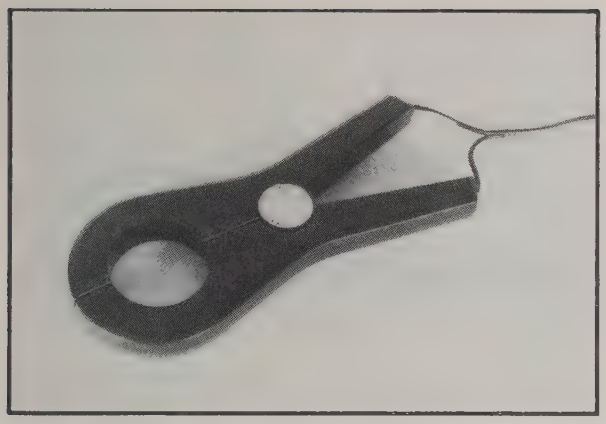


Figure 6-5. 80I-600 CURRENT TRANSFORMER

6-32. Operation

6-33. Use the following procedure for operating the 8040A with the 80I-600 transformer:

1. Plug the 80I-600 dual-banana plug into the mA and COMMON input terminals on the 8040A.
2. Depress the AC and mA pushbuttons.
3. Select the desired current range in accordance with Table 6-2.
4. Clamp 80I-600 around current carrying conductor to be measured.
5. Observe ac current reading in amperes on the 8040A readout.

NOTE

Clamping the 80I-600 around more than one current carrying conductor at a time procedures a reading that is the vector sum of the currents in the conductors.

Table 6-2. 8040A RANGES FOR CURRENT TRANSFORMER (80I-600)

8040A RANGE SELECTED	8040A CURRENT RANGE WITH 80I-600 TRANSFORMER
2000	200A to 600A
200	20A to 200A
20	2A to 20A

6-34. HIGH VOLTAGE PROBE (80F-5)

6-35. Introduction

6-36. The Model 80F-5 Voltage Divider shown in Figure 6-6 allows measurement of up to 5k volts dc to be made using Fluke 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

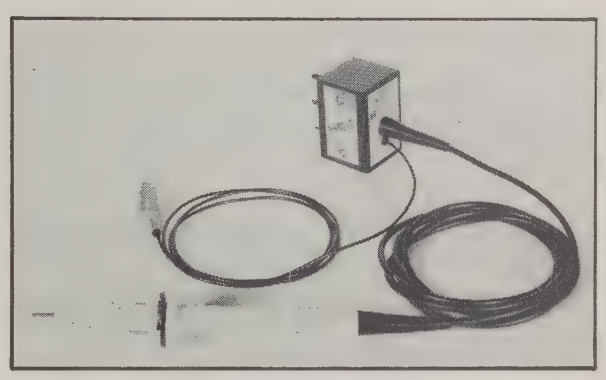


Figure 6-6. 80F-5 VOLTAGE DIVIDER

6-37. Physical design of the Model 80F-5 allows direct mating to the input terminals of the Fluke voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

6-38. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohms or greater) at null.

6-39. Cleaning

6-40. Accumulation of dust or dirt particles between the output terminals of the Model 80F-5 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-41. Calibration

6-42. The Model 80F-5 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is

specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-5 has been in non-operating state for at least four hours at a temperature of 23°C.

6-43. Test equipment requirements are a stable 1000 volt dc source such as the Fluke Model 332B Voltage Calibrator and the Fluke voltmeter. To calibrate the Model 80F-5 perform the following steps:

NOTE

The input resistance of the voltmeter must reach that of the 80F-5.

1. Calibrate the Fluke voltmeter.
2. Install the Model 80F-5 on the Fluke voltmeter input terminals.
3. Unscrew the strain relief on the input cable of the Model 80F-5 and remove the front cover.
4. Select the appropriate dc voltage range on the Fluke voltmeter.
5. Apply 1000 volts dc to the Model 80F-5 high voltage probe.
6. Adjust the variable resistor on the Model 80F-5 for a 1.0 volt dc indication on the Fluke voltmeter.
7. Remove the voltage from the Model 80F-5 high voltage probe.
8. Install the Model 80F-5 front cover and strain relief.

6-44. HIGH VOLTAGE PROBE (80F-15)

6-45. Introduction

6-46. The Accessory Model 80F-15 Voltage Divider, shown in Figure 6-7, allows measurement of up to 15k volts dc to be made using Fluke 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

6-47. Physical design of the Model 80F-15 allows direct mating to the input terminals of the Fluke voltmeters. A high voltage probe facilities connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

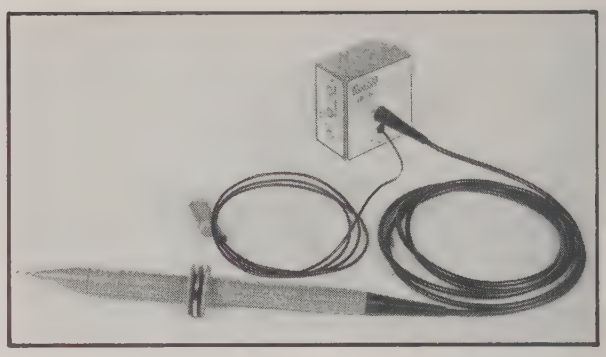


Figure 6-7. 80F-15 VOLTAGE DIVIDER

6-48. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

6-49. Cleaning

6-50. Accumulation of dust or dirt particles between the output terminals of the Model 80F-15 can be removed using clean dry pressurized air. Stubborn particles can be removed following an application of isopropyl alcohol.

6-51. Calibration

6-52. The Model 80F-15 division ratio should be checked every month or every year depending on the accuracy requirement. Ratio accuracy stability is specified at ±0.01% per month and ±0.05% per year. Calibration should be accomplished only after the Model 80F-15 has been in the non-operating state for at least four hours at a temperature of 23°C.

6-53. Test equipment requirements are a stable 1000 volt dc source such as the Fluke Model 332B Voltage Calibrator and the Fluke voltmeter. To calibrate the Model 80F-15, perform the following steps:

NOTE!

The input resistance of the voltmeter must match that of the 80F-15, see paragraph, REQUIRED VOLTMETER INPUT RESISTANCE, under specifications.

1. Calibrate the Fluke voltmeter.
2. Install the Model 80F-15 on the Fluke voltmeter input terminals.

3. Unscrew the strain relief on the input cable of the Model 80F-15 and remove the front cover.

4. Select the appropriate dc voltage range on the Fluke voltmeter.

5. Apply 1000 volts dc to the Model 80F-15 high voltage probe.

6. Adjust the variable resistor on the Model 80F-15 for a 1.0 volt dc indication on the Fluke voltmeter.

7. Remove the voltage from the Model 80F-15 high voltage probe.

8. Install the Model 80F-15 front cover and strain relief.

6-54. HIGH VOLTAGE PROBE (80K-40)

6-55. Introduction

6-56. The Accessory Model 80K-40 Voltage Divider, shown in Figure 6-8 allows measurement of up to 40k volts dc to be made using Fluke 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

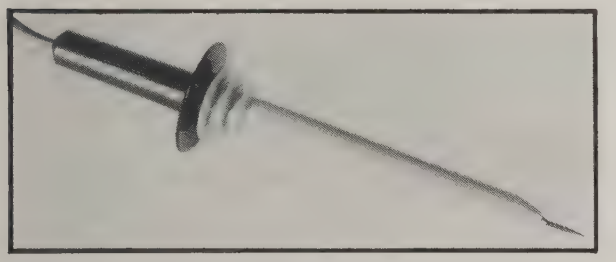


Figure 6-8. 80K-40 VOLTAGE DIVIDER

6-57. Physical design of the Model 80K-40 allows direct mating to the input terminals of the Fluke voltmeters. A high voltage probe facilities connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

6-58. HIGH FREQUENCY PROBE (81RF)

6-59. Introduction

6-60. The Model 81RF High Frequency Probe, Figure 6-9, extends the frequency range of the DVM/DMM to include 100 kHz to 100 MHz for ac

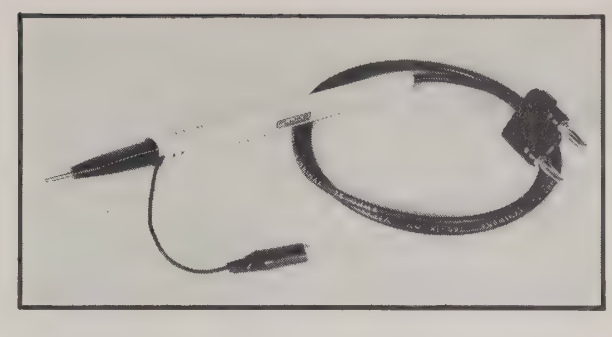


Figure 6-9. 81RF HIGH FREQUENCY PROBE

voltage measurements from 0.25 to 30V rms. The 81RF operates in conjunction with the dc voltage ranges, and is connected to the DVM/DMM using a shielded dual-banana plug and, when necessary, a dual banana adaptor.

6-61. HIGH FREQUENCY PROBE (82RF)

6-62. Introduction

6-63. The Model 82RF High Frequency Probe, Figure 6-10, allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30V rms. It is designed to be used with voltmeters having an input impedance of 10 megohms ±10%. It may be used with a voltmeter having an input impedance higher than 10 megohms provided the input is externally shunted to make the equivalent input impedance equal to 10 megohms.

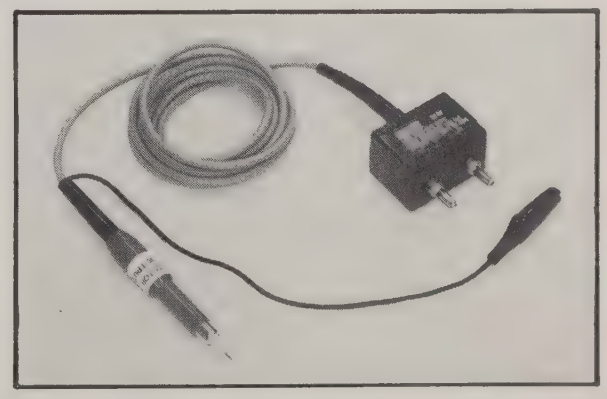
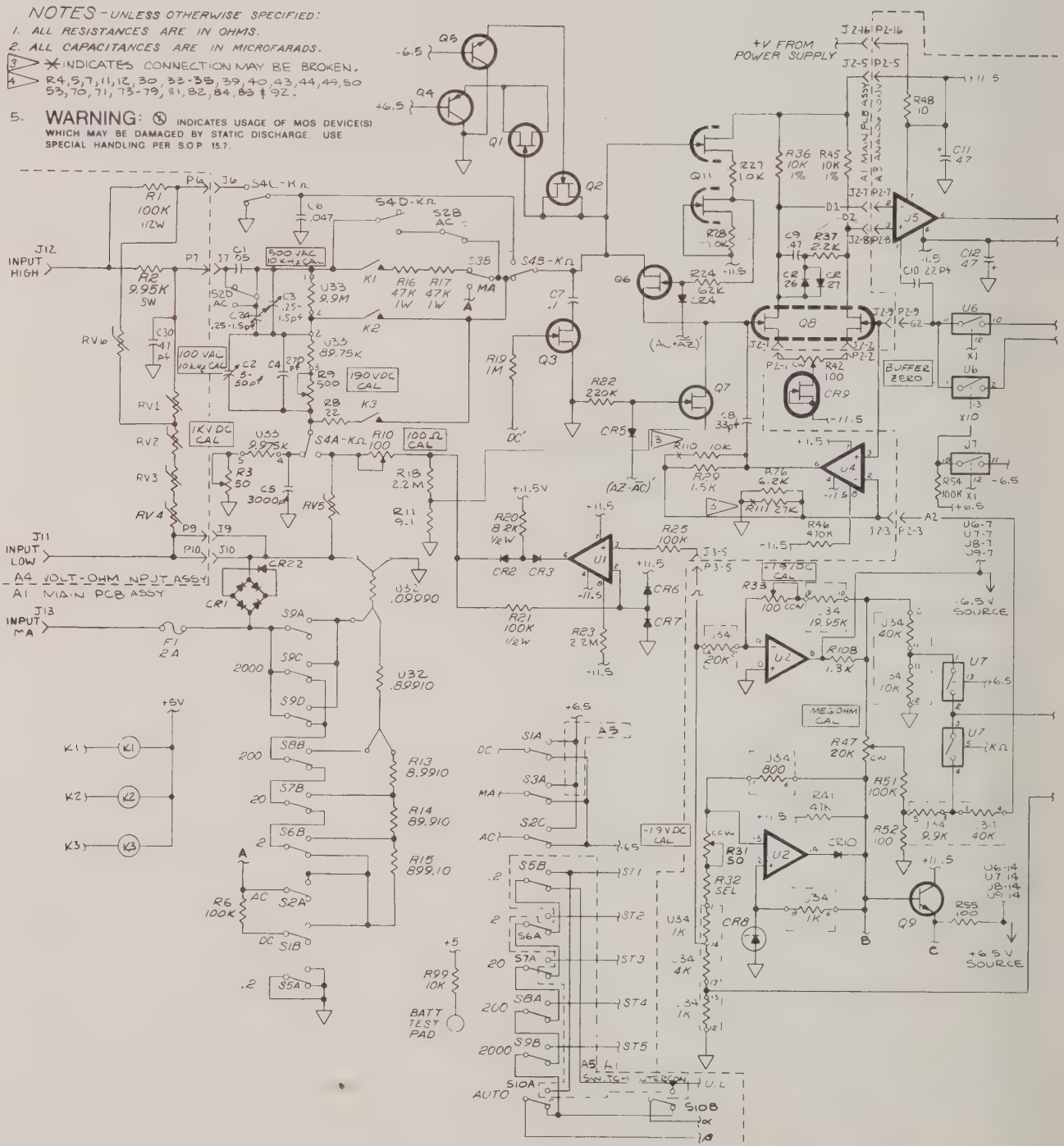


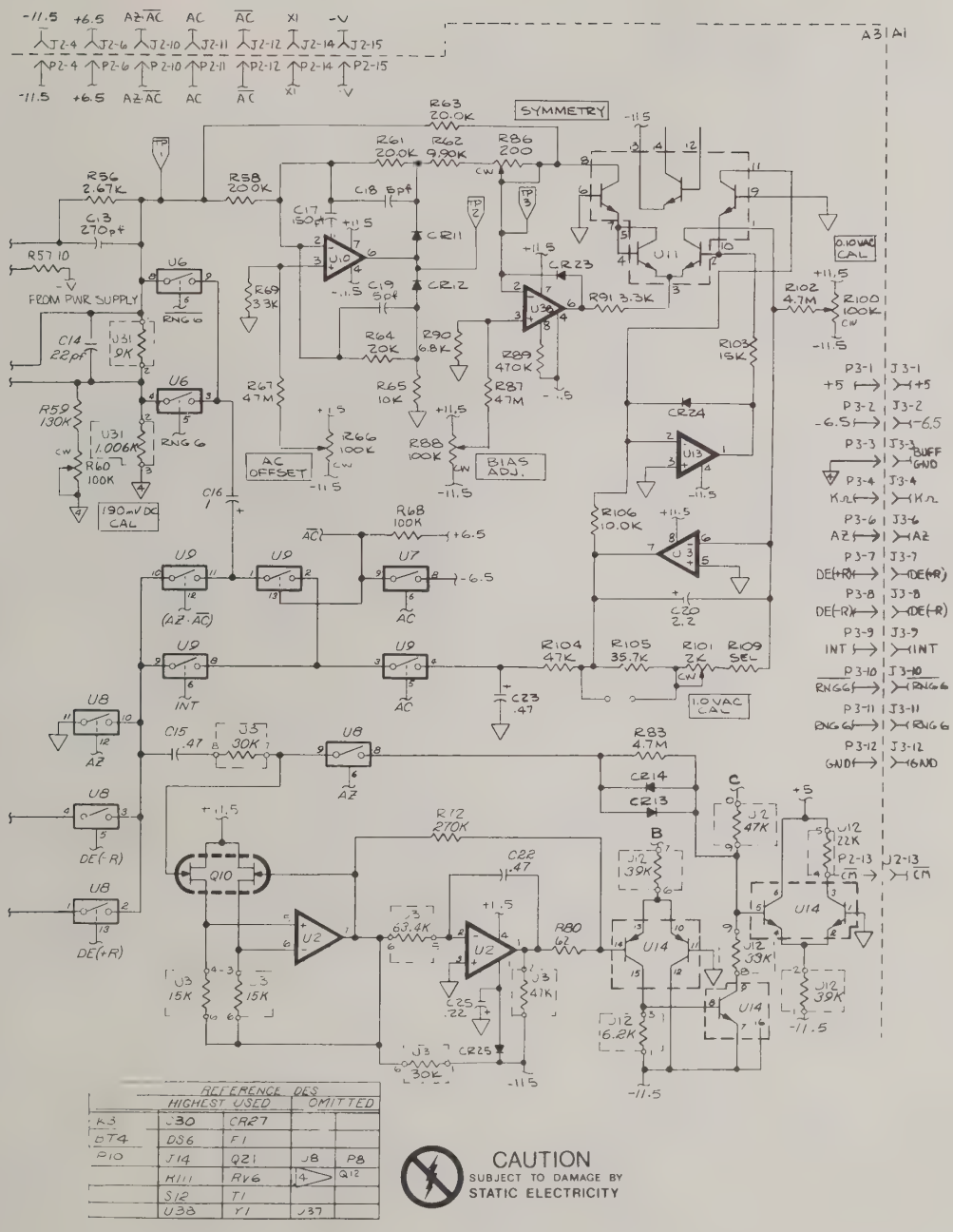
Figure 6-10. 82RF HIGH FREQUENCY PROBE

6-64. Circuitry within the 82RF consists of a capacitor-coupled rectifier circuit which responds to the peak value of the input waveform. The output is positive polarity dc which is calibrated to be equivalent to the rms value of a sine wave.

Section 7
Schematic Diagrams

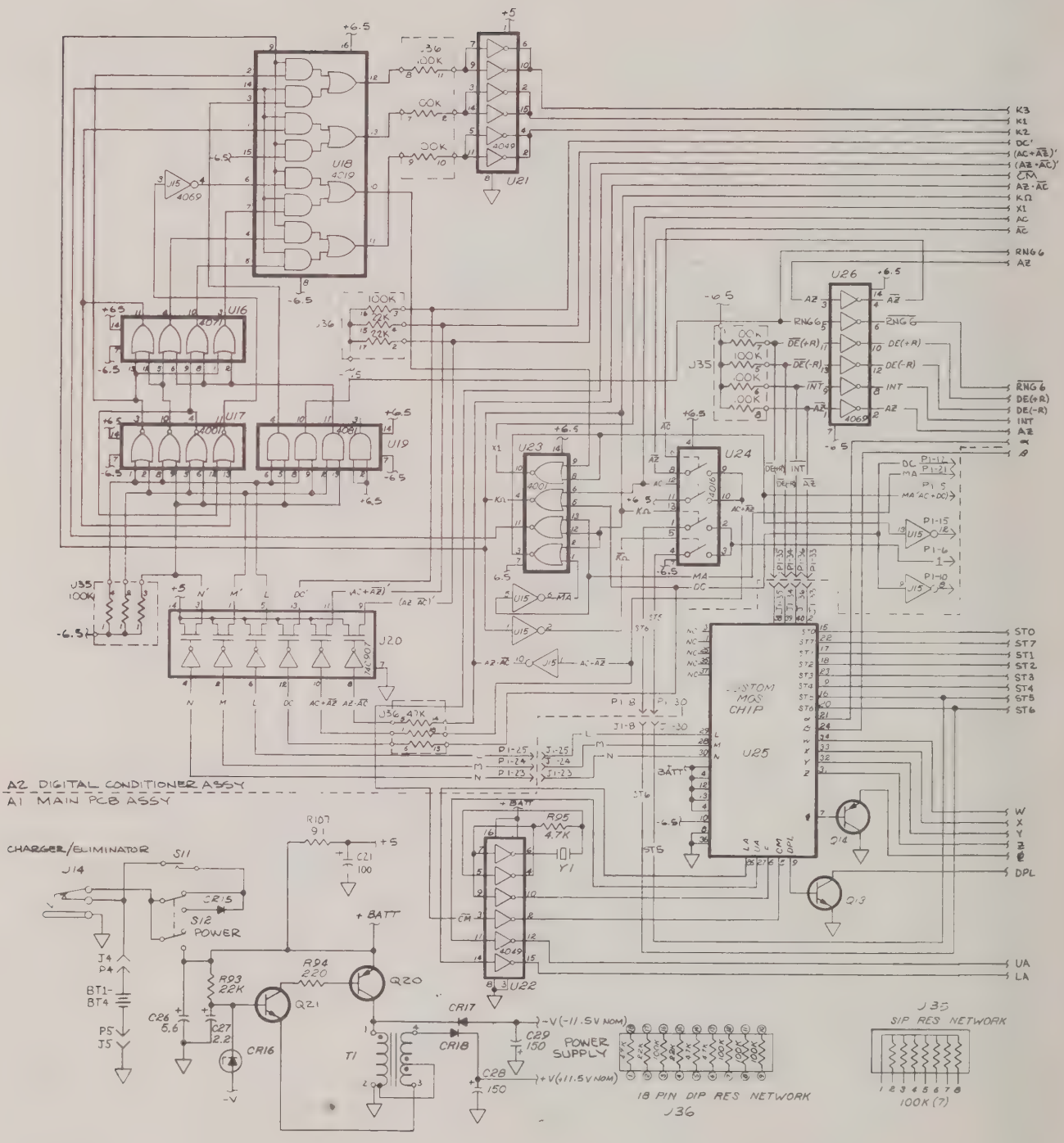
FIGURE	TITLE	PAGE
7-1	Analog Schematic Diagram	7-2 & 7-3
7-2	Digital Schematic Diagram	7-4 & 7-5


NOTES - UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCES ARE IN OHMS.
2. ALL CAPACITANCES ARE IN MICROFARADS.
3. * INDICATES CONNECTION MAY BE BROKEN.
R4,5,7,11,12,30 33-35,39,40,43,44,49,50 53,70,71,73-79, 81,82,84,85 & 92.
5. WARNING: INDICATES USAGE OF MOS DEVICE(S) WHICH MAY BE DAMAGED BY STATIC DISCHARGE. USE SPECIAL HANDLING PER S.O.P. 15.7.
A4 VOLT-OHM INPUT ASSY
A1 MAIN PCB ASSY
A1 MAIN PCB ASSY
A3 ANALOG ASSY
+V FROM POWER SUPPLY
INPUT HIGH
INPUT LOW
INPUT MA
BUFFER ZERO
MEGOHM CAL
+6.5 V SOURCE
-6.5 V SOURCE
BATT TEST PAD
AUTO
MANUAL
A5 RANGE SWITCH
INTERCON



REFERENCE DES				
	HIGHEST USED		OMITTED	
K3	J30	CR27		
DT4	DS6	F1		
P10	J14	Q21	J8	P8
	K111	RV6	4	Q12
	S12	T1		
	U38	Y1	J37	

Figure 7-1. ANALOG SCHEMATIC DIAGRAM


A2 DIGITAL CONDITIONER ASSY
A1 MAIN PCB ASSY
CHARGER/ELIMINATOR
J14
S11
S12
POWER
CR15
J4
P4
BT1-
BT4
P5
J5
R107
91
C21
100
+BATT
R93
22K
R94
220
Q20
Q21
C26
5.6
C27
2.2
CR16
CR17
CR18
T1
C28
150
C29
150
POWER SUPPLY
-V(-11.5V NOM)
+V(+11.5V NOM)
R95
4.7K
Y1
U22
4049
U25
CUSTOM MOS CHIP
Q13
Q14
J35
SIP RES NETWORK
100K(7)
J36
18 PIN DIP RES NETWORK
U18
4519
U16
4071
U17
4081
U19
U20
14490?
U21
4049
U23
4001
U24
4016
U26
4069
K3
K1
K2
DC'
(AC+AZ)'
(AZ+AC)'
AZ·AC
KΩ
X1
AC
RNG6
AZ
STO
ST7
ST1
ST2
ST3
ST4
ST5
ST6
W
X
Y
Z
DPL
UA
LA

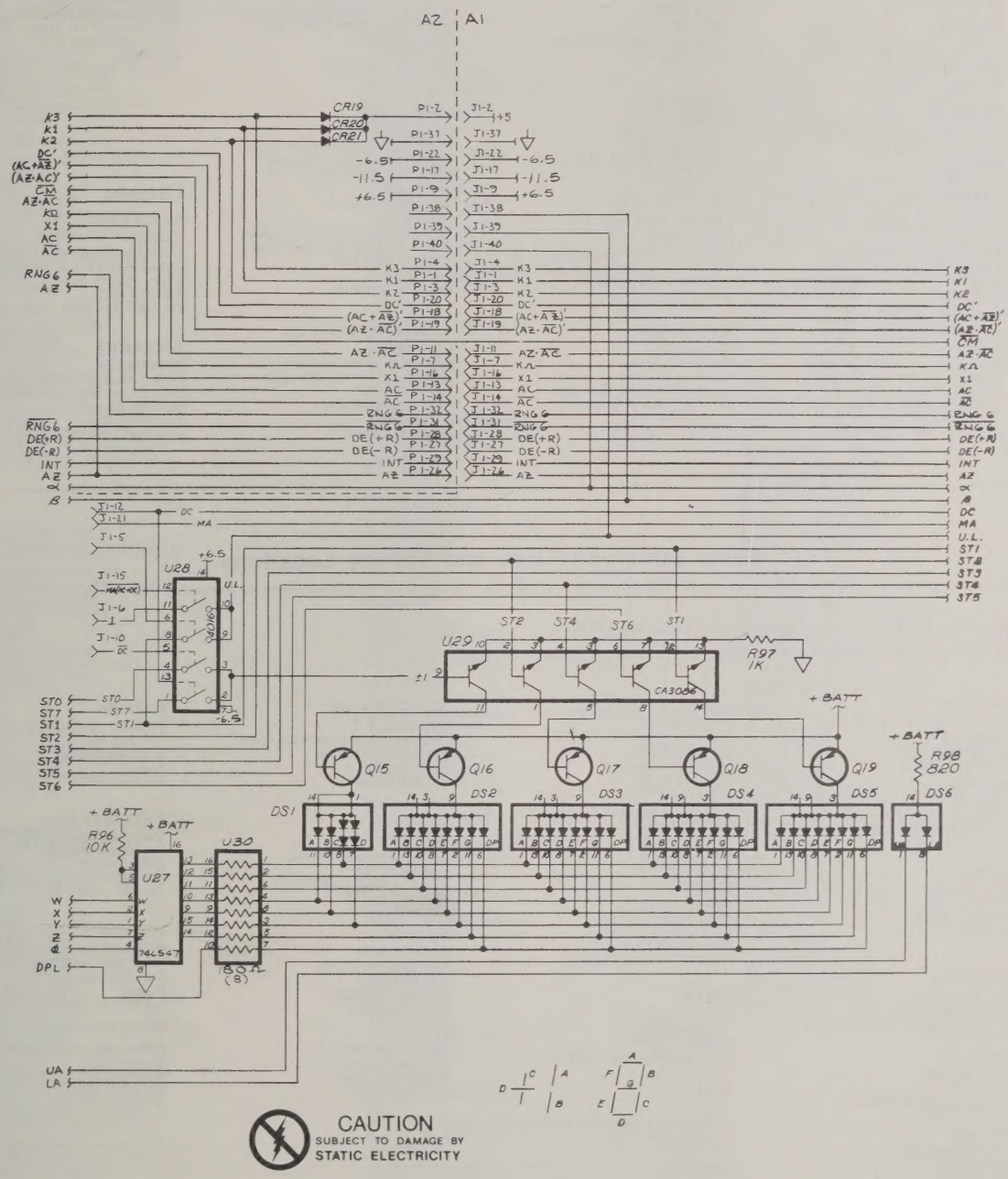


Figure 7-2. DIGITAL SCHEMATIC DIAGRAM

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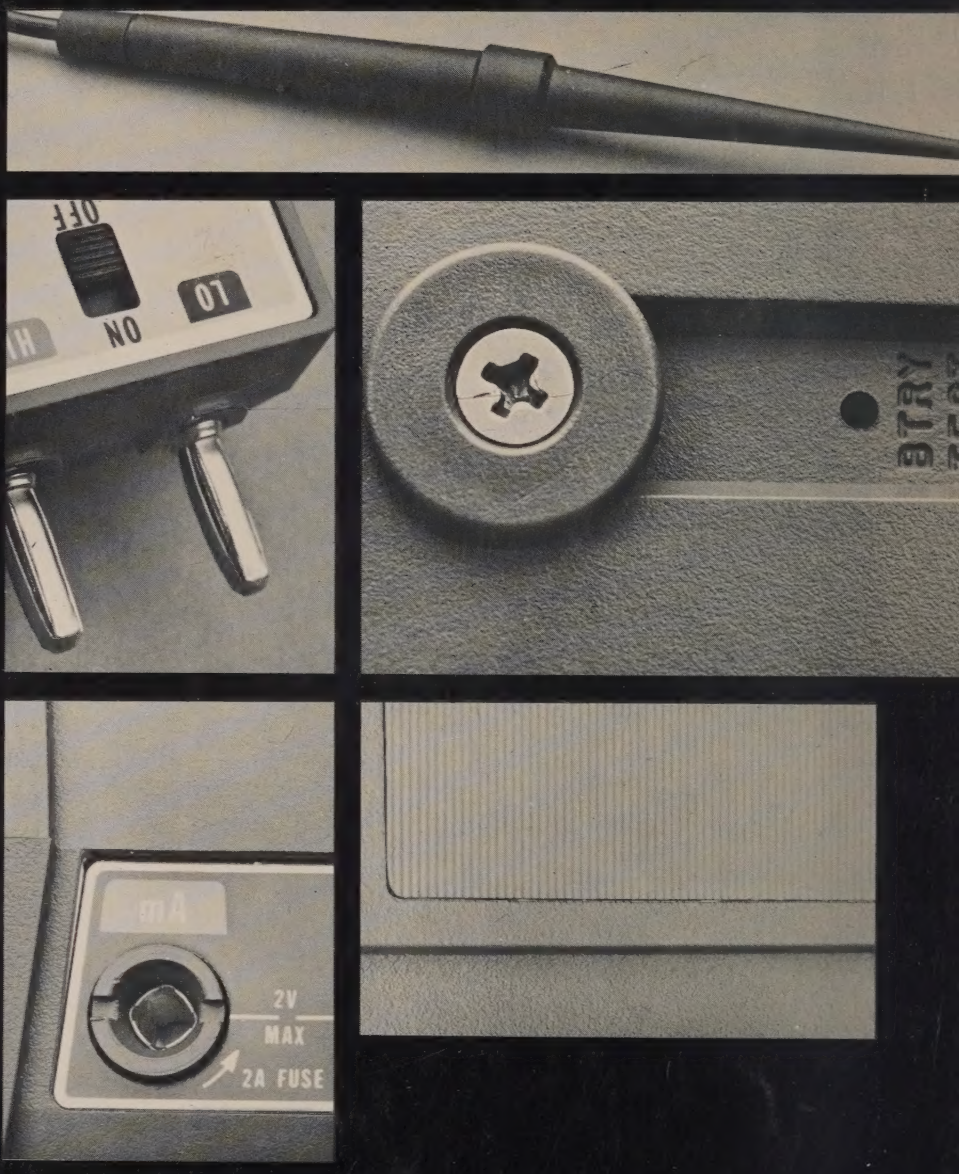

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